CONFIDENTIAL VOICE – THE SECRET REVEALED

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By
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Declaration

I hereby declare that this dissertation is my own unaided independent work. It has not been submitted before for any degree or examination at this or any other academic institution, nor has it been published in any form.

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August 2014

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"For in Him we live and move and have our being." – Acts 17:28
"Then he said to me, 'This is the Word of the Lord to you, saying, Not by might, nor by power, but by my Spirit', says the Lord of hosts." – Zechariah 4:6

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Abstract

Rationale: Evidence based practice proposes an ethical method of addressing longstanding questions about clinical practice in communication disorders. The existing knowledge base available on clinical interventions is frequently incomplete, potentially incorrect and biased according to Dodd (2007). Confidential Voice Therapy technique is a technique that was introduced by Colton and Casper in 1990 and has been used to treat a myriad of voice disorders since its inception. A small number of studies have been done to evaluate this treatment's efficacy. It has been proven effective at a physiological level and patients have perceived it to be beneficial. However the founders themselves have stated that this technique it is not effective for all patients it was employed on. However they failed to state why this is so.

Aims: The current study looked at *how* the confidential voice technique changes the voices of patients with hyperfunctional voice disorders physiologically, acoustically and in terms of air flow, as well as patients' perceptions of the technique and its effect on their voices.

Method: A quasi-experimental design, single group pre-test post-test design was employed. A sample of twelve individuals with hyperfunctional voice disorders were examined using a flexible fiberoptic examination, acoustic analysis, aerodynamic measures, a self-constructed questionnaire and stroboscopic examination prior to employing confidential voice technique and again during the use of confidential voice technique. The results of the acoustic analysis and aerodynamic measures were analysed using paired t-tests while the questionnaire and SERF results were analysed descriptively.

Results: The overaching result of this study was that the confidential voice technique did not have a significant effect on the voices of individuals with hyperfunctional voice disorders. There were exceptions to this, as five out of thirty-two parameters were significant in terms of acoustic analysis (i.e. Average Fundamental Frequency, Mean Fundamental Frequency, Average Pitch Period, Relative Average Pertubation and Smoothed Pitch Perturbation Quotient) and half of the aerodynamic measures used were significant (i.e. Maximum SPL, Maximum Pitch, Pitch Range, Phonation Time and Peak Inspiratory Airflow). Stroboscopic evaluations revealed changes in glottal closure, mucosal wave and amplitude, supraglottic activity and phase closure. In terms of the participants perceptions, the majority were able to identify the need for the technique however felt that it required a significant amount of concentration and limited them in their daily lives.

Conclusions: Despite the lack of statistical significance the results of this study have provided information that should inform practice and result in more successful treatment of patients as the clinician should now be able to estimate the potential effectiveness of the technique for a specific patient with a hyperfunctional voice disorder. It is envisioned that the present study provided objective information on the question of *how* and *why* confidential voice technique works in the treatment of hyperfunctional voice disorders as well how patients perceive the technique which has implications for therapeutic adherance.

Keywords: Voice therapy; Hyperfunctional Voice Disorders; Confidential Voice; Evidence-based practice

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Introduction and Rationale

The current research focused on providing evidence for the effectiveness of the Confidential Voice technique in terms of its effects on the physiological, acoustic and aerodynamic properties of voice. Specifically the research attempted to address how the confidential voice technique alters the voice. The introduction aims to provide the reader with an understanding of the existing knowledge on the therapy technique as well as highlight the need for further research into this technique thereby establishing a niche for the current research project. The introduction will discuss the progression of voice therapy since its inception and particular emphasis will be placed on the treatment of hyperfunctional voice disorders. Current research on the technique will be reviewed as well as the need for evidence in the field of voice therapy and speech-language therapy as a whole as we move towards our treatments being more evidence-based.

Rationale

Voice therapy is an effective treatment approach that has been used independently or in conjunction with other treatments, i.e. surgical and/or pharmacological, in the treatment of voice disorders (Casper & Colton, 2000). Despite its prominence as a treatment approach, voice therapy is a fairly new area of treatment in that it has only been part of the scope of practice of speech-language therapists for the last 83 years (Stemple, Glaze & Gerdeman, 2000). Initially, voice therapy was a combination of the knowledge the speech correctionists had acquired from training in public speaking, oral interpretation and theatre arts (Stemple, Glaze & Gerdeman, 2000). The understanding they had acquired from the above areas were combined with knowledge of human anatomy, physiology, psychiatry and pathologies of the laryngeal mechanism (Stemple, Glaze & Gerdeman, 2000). As the field grew, the knowledge base of the speech therapist had to expand into vocal fold histology, biomechanics of the laryngeal tissue, the acoustics of voice, aerodynamics of voice production, visual imaging and interpretation of vocal function (Stemple, Glaze & Gerdeman, 2000). Voice therapists have three fundamental functions: are assessment of laryngeal function using perceptual, acoustic, aerodynamic and visual imaging techniques; identification and modification or elimination of the functional causes of the voice disorder; and finally developing a therapy plan that will remediate the voice disorder and return the voice to improved function (Stemple, Glaze & Gerdeman, 2000). An understanding of the etiologic factors that lead to the development of voice disorders, in addition to appropriate diagnostic techniques to discovering the cause are necessary skills

(Stemple, Glaze & Gerdeman, 2000). Based on the above fields of knowledge, voice therapists are required to develop a repertoire of clinical management approaches for remediating voice disorders (Stemple, Glaze & Gerdeman, 2000). One of these approaches is confidential voice.

Dodd (2007) and many others (Reilly, 2004; Bernstein Ratner, 2007; Dollaghan, 2004; Kent, 2006) have proposed that speech-language therapy join the movement, as other health and social care professions have, of making our treatments evidence based. Evidence-based practice in the field of speech therapy has the potential to better current interventions for individuals with communication disorders, expand resources for services and improve the perception of the profession (Dodd, 2007).

Ethical treatment is one in which the therapist upholds the principles of beneficence, non-maleficence, and autonomy (www.saslha.co.za/A_CodeOfEthics.asp). The principle of beneficence means that the therapist will do what is right for the patient. This implies that the therapist will provide the correct treatment for the diagnosis. The principle of non-maleficence means that the therapist will do no harm. This implies that the therapist will provide a treatment that is beneficial to the patient rather than harmful. Autonomy refers to the patient's capacity to be the decision maker regarding their treatment. This principle ties in with informed consent, which refers to the patient being given all information required to make a decision on their treatment or therapy by the proposed treating professional (Corey, Corey & Callanan, 2011). Therefore in order to adhere to ethical principles that govern our practice as speech-language therapists we need to ensure that we have a deep understanding of the treatments we provide our patients in order to ensure they are beneficial and effective. It is therefore not surprising that our field has been inundated with efficacy studies of treatments we offer our patients. These studies in turn form a database and the evidence base that our field is in need of.
It is therefore the hope that this study would contribute to the current evidence base of voice therapy.

Introduction and Literature Review

The science behind voice therapy

The first attempts to evaluate the effects of voice therapy methods can be traced back to the 1940s, where researchers such as Froeschels, Preacher and Hollinger contributed to the knowledge pool (Thomas & Stemple, 2007). This knowledge base grew in the 1970s where there were major advances at the investigational level (Verdolini, Ramig & Jacobson, 1998). This was the first interest in basic science to answer clinical questions (Verdolini, Ramig & Jacobson, 1998). Moore, a speech scientist and speech-language pathologist stated in 1971 that voice therapy lacked a scientific basis (Thomas & Stemple, 2007). He concluded that many methods used in voice therapy at the time were not based on scientific evidence but rather on the clinician's preference, and it is for this reason that voice therapy was viewed fundamentally as an art (Thomas & Stemple, 2007). Moore's sentiments were echoed by many others such as Pannbacker, Perkins, Ramig and Verdolini and the field began to call for empirical evidence for therapeutic techniques (Thomas & Stemple, 2007). It is as a result of these inquests and those of others that the field of voice therapy has slowly evolved from being a fundamental art to the scientific based use of therapeutic techniques (Thomas & Stemple, 2007).

Thomas and Stemple (2007) document the three stages of development that voice therapy outcomes research has undergone. The first stage includes that of descriptive case reports, expert opinions and anecdotal comments (Hillman *et al*, 1990). Although these informal documentations regarding voice therapy provide relevant information for treatment at the individual patient level, they do not allow for generalisation to the greater population of voice therapy patients (Thomas & Stemple, 2007). The general lack of objective measures used in this period made the scientific study of voice challenging (Thomas & Stemple, 2007). The second stage was the instrumental stage which was realised in the 1980s as there were great technological advances in acoustic and visual perceptual measures for voice (Thomas & Stemple, 2007). Johnson (1985) stated "the profession is at the threshold of being able to validate years of clinical practice in voice disorders with efficient data collection techniques" (Johnson, 1985:129). Outcomes studies increased in the 1990s using data that was collected from instrumental assessments of voice (Pannbacker, 1998). Much of the research conducted during this time was flawed at a methodological level and lacked rigour in design (Thomas & Stemple, 2007). Many of these studies failed to meet the rigorous randomised, control criteria required of pure efficacy research (Pannbacker, 1998). Furthermore many of the studies in this period failed to demonstrate a cause-effect relationship between the chosen therapy method and voice change due to the influence of extraneous variables (Thomas & Stemple, 2007). The third and final stage in voice therapy development was the adoption of rigorous experimental designs which included randomised control trials or well controlled within subject designs such as the study by Behrman and Orlikoff (1998, cited in Thomas & Stemple, 2007). These research initiatives allowed investigators to eliminate extraneous variables and offer cause-effect determinations (Thomas & Stemple, 2007).

The slow progress in treatment outcomes research could possibly be attributed to the complexity of this form of research (Thomas & Stemple, 2007). Ethical considerations such as delayed versus no treatment experimental designs, small sample sizes due to lack of participants, the lack of controlled methods in voice therapy and the heterogeneous nature of patient etiologies in group studies are factors that have limited treatment outcomes research in the field of voice (Thomas & Stemple, 2007). In addition, most of the research demonstrating the influence of voice therapy has been done on adults (Thomas & Stemple, 2007). Despite these studies, clinicians tend to rely upon information related to the particular outcomes associated with specific methods of treatment of which research studies are scarce (Thomas & Stemple, 2007).

Functional Voice Disorders

The revolutionary nature of voice therapy has been underpinned by the necessity to treat voice disorders. Voice disorders exist when the structure or the function of the voice fails to meet the voicing needs expected by the speaker according to Stemple *et al.* (2000). Functional voice disorders can be defined as the inappropriate use or functioning of the vocal mechanism (Stemple *et al.,* 2000). According to Rosanowski and Eysholdt (2006), this group of voice disorders has no obvious organic change affecting the phonatory structures and are usually multifactorial in etiology. Constitutional, habitual, stress-related and psychogenic have been identified as contributing factors (Rosanowski & Eysholdt, 2006). It is difficult in any given case to determine the relative contribution of specific factors to the overall presentation (Rosanowski & Eysholdt, 2006). Usually multiple factors can be identified that may reinforce one another under certain conditions (Rosanowski & Eysholdt, 2006). A vicious cycle may perpetuate a chronic voice disorder, which may later give rise to morphologic changes, such as vocal nodules (Rosanowski & Eysholdt, 2006). Typically functional voice disorders are subdivided into hyperfunctional and hypofunctional voice disorders and are for the most part associated with a general impairment for all aspects of voice function (Rosanowski & Eysholdt, 2006).

Hyperfunctional dyphonia occurs predominantly in talkative, extroverted individuals particularly women (Rosanowski & Eysholdt, 2006). A dynamic balance typically exists between subglottic pressure and muscular tone in the larynx (Rosanowski & Eysholdt, 2006). In the event of hyperfunction the balance is shifted to higher pressures and tone values, resulting in the system functioning in an uneconomical and inefficient manner (Rosanowski & Eysholdt, 2006). Use of this uneconomical manner of phonation for an extended period of time results in sites of connective tissue hyperplasia developing at the junction of the anterior and middle thirds of the vocal cords (Rosanowski & Eysholdt, 2006). Vocal nodules are prime examples of a secondary morphological changes based on the primary functional disorder (Rosanowski & Eysholdt, 2006).

The voices of individuals with hyperfunctional voice disorders typically are:

- higher in pitch
- strained
- harsh
- scratchy
- reduced in the ability to be raised or modulated (Rosanowski & Eysholdt, 2006)
- Increased muscle tension is also common in the neck and throat musculature (Rosanowski & Eysholdt, 2006)
- Hourglass shaped glottic closure pattern
- Increased supraglottal activity during phonation, which could obscure the view of the true vocal folds upon examination (Rosanowski & Eysholdt, 2006)

An example of a functional voice disturbance is muscle tension dysphonia, which is hypothesised to be the result of individuals speaking with inappropriately higher levels of muscle tension (Sharp & Tasko, 2011). A second example is puberphonia, where despite normal anatomical changes, an adolescent male maintains a pre-pubesent high pitched voice (Sharp & Tasko, 2011). Furthermore, the most frequently occuring cause, is inappropriate vocal use such as excessive talking, shouting , growling which can contribute towards the development of benign vocal fold lesions such as nodules, polyps or contact ulsers (Sharp & Tasko, 2011). In some instances, an individual may develop maladaptive techniques in order to compensate for an organic disturbance in turn worsening the voice disturbance (Sharp & Tasko, 2011).

Hypofunctional voice disorders are the second catgory of functional voice disorders.

These disorders are characterised by:

- prolonged voice use or a habitual tendancy to speak with too little effort (Rosanowski & Eysholdt, 2006).
- The dynamic balance of vocal fold vibration is shifted downwards towards low pressures and tone values (Rosenowski & Eysholdt, 2006).
- The body posture of individuals with hypofunctional voice disorders are typically lower in muscular tension, shallow breathing, and a weak, breathy sounding voice (Rosanowski & Eysholdt, 2006).
- These individuals therefore present with glottic insufficiency (Rosanowski & Eysholdt, 2006).

An example of a hypofunctional voice disorder could be vocal fold paralysis resulting from a host of etiologies or surgical procedures (Bansal, 2013).

Many cases of voice disorders, however, have a functional and organic component that may have caused and perpetuate the disorder (Fogle, 2012). For example, in the case of vocal nodules, the acute phonotrauma caused by vocal abusive behaviours such as screaming, coughing, throat clearing, smoking, use of the wrong pitch, hard glottal attacks and chronic loudness may have originally caused the voice disorder (Fogle, 2012). These could be considered "functional" behaviours that may result in an "organic" disorder, i.e. vocal nodules (Fogle, 2012; Andrews, 2006; Boone *et al.*, 2009; Colton *et al.,* 2011). Neurologically based voice disorders may also have organic and functional components to the presenting voice problem (Fogle, 2012). Many disorders present with a hyperfunctional component such as tension along with a hypofunctional component such as breathiness (Fogle,2012).

The focus of the current research will be on hyperfunctional voice disorders. However, both hyperfucntional and hypofunctional voice disorders fall into the category of physiologic voice disorders and require the voice therapist to have a good understanding of the anatomy and physiology of the human voice in order to transition the disordered voice to its appropriate form (Thomas & Stemple, 2007) which is the primary goal of therapy (Fogle, 2012). It is for this reason that the anatomy and physiology of the larynx, the source of voice, is discussed.

The location, anatomy and physiology of the larynx

The larynx is a short passageway that links the laryngopharynx with the trachea (Tortora & Derrickson, 2006). It is situated in the midline of the neck anterior to the esophagus and the fourth and sixth cervical vertebrae and is surrounded by a vast number of blood vessels, nerves and glands (Tortora & Derrickson, 2006; Titze, 1994). The wall of the larynx is comprised of nine portions of cartilage, three occurring singularly and three occur in pairs (Tortora & Derrickson, 2006). Of the paired cartilages the arytenoid cartilages are the most important as they influence positional and tension changes of the vocal folds (Tortora & Derrickson, 2006). Within the larynx the glottis is situated at the most narrow portion of the airway. The glottis is created by the pair of vocal folds, comprised of bands of mucous membrane, connective tissue and the muscle (thyrovocalis muscle) slung between the arytenoid cartilages and the thyroid cartilage in order for them to move into and out of the airstream (Tortora & Derrickson, 2006; Seikel, King & Drumright, 1997; Titze, 1994).

Fine Structure of the vocal folds

The vocal folds are composed of five layers of tissue (Seikel, King & Drumright, 1997; Titze, 1994). The first and most superficial layer is comprised of a thin sheet of squamous epithelium less than 1mm thick which gives the vocal folds the glistening white appearance which is visible during a laryngoscopic examination (Seikel, King & Drumright, 1997; Titze, 1994). The second layer is the lamina propria, comprising of three layers of different tissues. Elastin fibers form the first two layers and the third is comprised of collagen fibers (Seikel, King and Drumright, 1997; Titze, 1994). The elastic fibers of the lamina propria serve to stretch, while the collagen fiber layer serves to prohibit extension and collectively form the vocal ligament that provides a stiffness and support to the vocal folds (Seikel, King & Drumright, 1997; Titze, 1994). The fifth and final layer of the vocal folds is the thyrovocalis muscle, which makes up the bulk of the vocal folds (Seikel, King & Drumright, 1997; Titze, 1994).

The physiology of the voice

The expiration of air from the lungs through the trachea forms the power for phonation (Wicklund, 2011; Davies & Jahn, 2004). The thoracic cage houses the lungs and below the lungs is the diaphragm (Davies & Jahn, 2004). As the diaphragm contracts it flattens, and pulls down towards the abdomen (Davies & Jahn, 2004). This movement has the effect of decreasing the pressure in the thorax and increasing the pressure in the abdomen (Davies & Jahn, 2004). The negative thoracic pressure draws air in through the trachea and into the lungs (Davies & Jahn, 2004). The abdomen has a pivotal role in phonation (Davies & Jahn, 2004). During the process of inhalation, the diaphragm contracts and descends, the abdomen is consequently compressed and its contents protrude (Davies & Jahn, 2004). The muscles lining the abdominal wall relax in order to accommodate this compression (Davies & Jahn, 2004).

The vocal folds adduct at the onset of phonation through the combined action of the lateral cricoarytenoid and interarytenoid muscles (Wicklund, 2011). Phonation is the process whereby the adductive force of the vocal folds is balanced with the subglottic air pressure (Davies & Jahn, 2004). This process is balanced in such a way that as the air pushes the vocal folds apart, decreasing the subglottic air pressure, the vocal folds immediately return to the adducted position (Davies & Jahn, 2004). The air pressure then builds up again until the vocal folds are blown apart (Davies & Jahn, 2004; Wicklund, 2011). The folds are then drawn together thereby constricting the airway (Wicklund, 2011). This creates a narrower space, which serves to suck the vocal folds back together again, this is known as the Bernoulli effect (Wicklund, 2011). The Bernoulli effect can be defined as air that moves from wider space to the narrower space; it increases in flow and decreases in pressure (Wicklund, 2011). This repeated process results in vocal fold vibration and consequently voice production (Davies & Jahn, 2004).

The Bernoulli effect creates a pattern of oscillation known as the mucosal wave (Wicklund, 2011). The mucosal wave is said to have four-stage opening and closing pattern, known as a phase or vibratory cycle (Wicklund, 2011). An opening and closing pattern is known as a phase (Wicklund, 2011). During a single phase of the mucosal wave the vocal fold initially opens from the bottom, next from the top, then it closes from the bottom, and finally closes at the top, thereby completing the phase (Wicklund, 2011). The vertical phase is defined as the time difference between the opening and closing of the inferior and superior edges of the folds (Wicklund, 2011). The longitudinal phase difference is defined as the time lag between the opening and closing of the vocal folds from the posterior portion to the anterior commissure (Wicklund, 2011). The vocal folds always open from posterior to anterior and closure is the reverse of this, i.e. anterior to posterior (Wicklund, 2011). The repetitive cycle of vocal fold closing and opening is known as the myoelastic aerodynamic theory of phonation (Gardner & Benninger, 2007). Factors that allow this to occur more quickly would be associated with an increase in vocal fold frequency and an elevated pitch (Gardner & Benninger, 2007). These would be increasing subglottic pressure, decreasing the mass of the vocal folds, or increasing the tension on the vocal folds (Gardner & Benninger, 2007). Likewise, decreased subglottic pressure, increased mass, or decreased tension would result in lowering of the pitch (Gardener & Benninger, 2007). A mass lesion, poor pulmonary support, a thicker vocal fold, or lessor tension would all be associated with decreased pitch (Gardner & Benninger, 2007). Loudness or intensity, however, is determined by the amplitude of the vibration (Gardener & Benninger, 2007). Loudness can be increased and decreased without impacting on the pitch of the voice (Gardener & Benninger, 2007).

The quality of voice is determined by the supraglottic structures of the vocal tract, namely, the larynx above the vocal folds, the pharynx and oral cavity (Davies & Jahn, 2004). These structures function as resonators for the sound produced by the vocal folds (Davies & Jahn, 2004). Resonance amplifies certain frequencies and amplifies them over the loudness of other frequencies within the original signal (Davies & Jahn, 2004). Through the manipulation of the size, shape and position of the supralaryngeal compartments the voice user can select and amplify a large vocal range (Davies & Jahn, 2004). By manipulation of the resonating structures within the vocal tract the human voice is capable of a total range of five octaves. However the range of an individual's voice is predetermined by the anatomy of the vocal tract (Davies & Jahn, 2004). Once the sound reaches the oral cavity it is further shaped and finally articulated (Davies & Jahn, 2004).

It is this articulated sound that may become disordered and therefore treatment approaches were designed to address the needs of individuals presenting with voice disorders.

Voice Therapy Approaches

An array of approaches to the treatment of functional voice disorders have emerged over the years (Thomas & Stemple, 2007). Stemple (2005) classifies these approaches into four categories namely, hygienic; physiologic; systemic and psychogenic. Hygienic voice therapy approaches focus predominantly on identification, followed by exclusion of poor vocal behaviours and development of appropriate vocal behaviours (Thomas & Stemple, 2007). Secondly, systemic voice therapy approaches are focused on modification and correction of vocal, respiratory and resonance systems which in turn lead to improvement in the voice condition (Thomas & Stemple, 2007). Thirdly, physiologic voice therapy approaches primarily focus on physiology in the belief that modifying the underlying physiology of voice production will result in improved voice (Thomas & Stemple, 2007). These approaches discuss treatment methods using anatomical and physiological terms (Thomas & Stemple, 2007). Stemple, Lee, D'Amico and Pickup (1994) propose that physiologic voice therapy approaches involve three fundamental components. The first component is improving the balance between the primary voice production systems; secondly, improving the strength, balance, tone and stamina of the laryngeal muscles and finally, developing a healthy mucosal covering of the true vocal folds (Stemple, Lee, D'Amico & Pickup, 1994). These approaches rely upon the clinician's understanding of normal voice production in order to transition the disordered voice to its most appropriate form (Thomas & Stemple, 2007). Fourthly the psychogenic approaches are aimed at releasing the patient's natural normal voice which has been inhibited by extreme muscular tension (Aronson, 1980). Aronson (1980) stated that the release could be achieved through mechanically relaxing the laryngeal musculature or by psychologically releasing the anxiety that lead to the tension.

Physiologic voice therapy approaches include confidential voice therapy (Colton & Casper, 1990); Vocal Function exercises (Stemple, 1993); the Accent Method (Smith & Thyme, 1996); Manual Laryngeal Musculoskeletal Reduction (Aronson, 1990); Resonant Voice Therapy (Lessac, 1993); and Lee Silverman Voice Treatment (Ramig, Coutryman, Thompson & Horii, 1995) (Thomas & Stemple, 2007). These six treatment approaches manage the voice disorder holistically with the primary objective of altering the overall physiology of voice production (Thomas & Stemple, 2007). With the exception of the Lee Silverman Voice Treatment each of the above mentioned approaches are used to treat functional voice disorders (Thomas & Stemple, 2007). Confidential Voice technique presented by Colton and Casper (1990) falls under the umbrella of physiologic voice therapy approaches and will be the focus of this research.

<u>Confidential Voice Technique</u>

Confidential voice therapy can be defined as the voice one would use when discussing confidential information with someone at close range (Colton & Casper, 1990; Verdolini-Marston *et al.,* 1995). According to Verdolini-Marston *et al.* (1995) confidential voice therapy is considered predominantly effective in the early stages of treatment for maximum early reduction of lesions and of dysphonia. Confidential voice is an approach that is used in the treatment of benign lesions, muscle tension dysphonia, hyperfunctional dysphonia, vocal fatigue and in early postoperative periods (Casper & Colton, 2000). It is used to reduce vocal fold contact and in so doing on a physiological level it is hypothesised to be associated with reduced vocal fold collision and reducing muscle tensions and hyperfunctional behaviour (Colton & Casper, 2000). The voice is breathy as it is produced with slightly abducted vocal folds (Colton & Casper, 2000). This abduction theoretically results in increased airflow and thereby reduced loudness (Colton & Casper, 2000). Colton and Casper (2000) based their physiological theory on Jiang and Titze's (1994) study that demonstrated that intraglottal contact appeared to increase as vocal fold adduction increased. Therefore Colton and Casper (2000) hypothesised that the inverse should hold true, that is that reduced intraglottal contact would cause reduced collision force. Based on the above, Colton and Casper (2000) hypothesised that decreased irritation caused by forceful intraglottal contact, as seen in hyperfunctional voice disorders, should support healing. Colton and Casper (2000) stated that if the technique is applied appropriately then supraglottal constriction and excessive muscle tension are also reduced.

Reduced vocal intensity that is associated with this technique is deemed an immediate benefit of this technique but according to Colton and Casper (2000) it is the element that is often deemed the drawback of the approach by other sceptics. At a physiological level, the reduction of hyperfunctional vocal behaviours is the fundamental benefit of this technique. This is deemed beneficial as the patient is required to change habitual patterns of voicing, to develop a heightened awareness of ambient noise levels and learn to make appropriate adjustments (Colton & Casper, 2000). The downfall of this technique is the difficulty in being heard above the ambient noise or in speaking situations that require louder phonation (Colton & Casper, 2000). It is in these situations that the individual needs to become imaginative in adjusting to the new speaking demands (Colton & Casper, 2000).

The confidential voice technique has five fundamental uses according to its creators. Firstly, it is used to eradicate hyperfunctional and traumatic vocal behaviours; secondly, its use allows for lesions to heal in the absence of continued vocally traumatic phonation; thirdly, it is thought to reduce vocal fatigue and excessive muscle tension; fourthly, it serves to reduce the internal vocal meter; and lastly it promotes a heightened awareness of voice use and speaking environment (Colton & Casper, 2000). At the very core of the technique its holistic aim is to create healthier vocal folds and an objective position which promotes healthy voice use which can be taught and expanded upon through the use of a variety of techniques (Colton & Casper, 2000).

Thomas and Stemple (2007) state that confidential voice technique is used early in therapy and patients are instructed to use the technique in all communicative interactions for a period of four weeks. Thereafter the patient is taught to use resonant voice (Thomas & Stemple, 2007). Colton and Casper (1996) and Casper (2000) relay summaries of fiberoptic and aerodynamic studies run on patients while employing the confidential voice technique. These studies report incomplete glottic closure which was confirmed by aerodynamic measures. The authors therefore deduced that these findings supported the use of confidential voice in hyperfunctional voice disorders (Thomas & Stemple, 2007). However, it should be emphasised, as the authors noted, that in some patients within these studies glottis closure patterns indicated hyperfunction (Thomas & Stemple, 2007). Therefore, glottal closure patterns in the patients producing confidential voice may vary between patients. This therefore suggests that confidential voice is appropriate in the treatment of some patients and not others (Thomas & Stemple, 2007).

The efficacy of confidential voice has been further investigated in comparison to other treatments such as resonant voice therapy. An extensive search of the literature yielded only two such studies (Verdolini-Marston *et al.*, 1995; Leddy, Samlan & Poburka, 1997). Verdolini-Marston *et al.* (1995) investigated the efficacy of these two methods, namely confidential voice therapy and resonant voice therapy, in the treatment of laryngeal nodules. Their study consisted of 13 participants, five participants were treated using confidential voice therapy, 3 were treated with resonant voice therapy and 5 were retained as a control group (Verdolini-Marston *et al.*, 1995). The participants were evaluated over a 12 day period by means of phonatory effort ratings, auditory-perceptual ratings of voice and visual-perceptual ratings of the larynx (Verdolini-Marston *et al.*, 1995). Results showed that some benefit could be noted between participants and those in the control group (Verdolini-Marston *et al.*, 1995). On all measures 60% (three out of five) of participants across all measures showed improvement over the two week period as compared to the control group (Verdolini-Marston *et al.*, 1995). However, there was little evidence that either confidential voice therapy was superior to resonant voice therapy or vice versa across all measures (Verdolini-Marston *et al.*, 1995). Interestingly both types of therapy had a similar likelihood of improving participants' voices, provided participants had generalised the technique to their everyday lives (Verdolini-Marston *et al.*, 1995). Therefore neither confidential voice therapy nor resonant voice therapy was superior.

Leddy *et al.* (1997) evaluated three treatment techniques commonly used in the treatment of hyperfunctional voice disorders namely confidential voice therapy, resonant voice therapy and the accent method. Three patients were treated using confidential voice, four using resonant voice therapy and three used the accent method (Leddy *et al.*, 1997). Leddy *et al. (*1997) measured the patients' outcomes using a client rating questionnaire and the Functional Communication Measure of Voice Disorders (FCMVD). Patients were asked a series of eight questions prior to treatment and the same eight questions post treatment in order to quantify their perception of change in their voice post treatment (Leddy *et al.*, 1997). This study reported benefit from all three techniques in treating functional voice. Leddy *et al.* (1997) reported that confidential voice is particularly effective in the treatment of nodules or laryngitis. They emphasised that it is not a technique that should be used indefinitely but rather this technique allows patients to have a voice they can use while their vocal tissue heals (Leddy *et al.*, 1997).

Based on the above mentioned literature it is clear that confidential voice has been found to be an effective intervention for individuals with voice disorders. In terms of the current knowledge base for confidential voice technique we know that on a physiological level it has the desired effect in that if produced correctly it yields incomplete glottic closure and also in addition we know that participants and therapists alike perceive an acoustic benefit as a result of this approach. However, is this information sufficient for therapists to make informed decisions regarding the treatment of a patient? The authors (Colton & Casper, 1996; Casper, 2000) of the technique have reported, as previously mentioned, that the technique is not effective for all patients with hyperfunctional voice disorders however the authors failed to explain why this is so.

Therefore it is important to understand how the technique works in order to determine if it has the desired effect when treating a disorder. As previously mentioned, the confidential voice technique has proven to be most effective in the treatment of vocal nodules (Leddy *et al.*, 1997). In order to understand why this is so, it is important to understand the pathophysiology of vocal nodules as well as the physiology of the technique. From this, one would be able to extrapolate reasons for why the technique was effective for this particular disorder. Vocal nodules are caused by vocal abuse and misuse which results in muscle tension or hyperfunction (Gallena, 2007). Over time, the area of the vocal folds which receive the greatest amount of impact during vibration, i.e. the juncture of the anterior third and posterior two thirds, becomes swollen and irritated, resulting in mucosal changes (Gallena, 2007). The development of vocal nodules begins with localised edema and erythema; over time this develops into a thickening; next a reddened, pliable, fluid-filled nodule; followed by a fibrous, whitened nodule (Gallena, 2007). Nodules, for the most part, occur bilaterally on the medial edge of the vocal fold (Gallena, 2007). The voice of an individual with vocal nodules often has a breathy component due to incomplete glottal closure or hourglass closure (Gallena, 2007). Moreover, due to the increase mass of the vocal nodule on the vocal cord, the pitch of the individual is often decreased with a reduced range (Gallena, 2007). The mucosal wave may also be reduced in the area surrounding the nodule (Gallena, 2007). Therefore, it is plausible why the confidential voice technique is recommended and effective in the treatment of vocal nodules as it is hypothesised to reduce vocal fold contact (Colton & Casper, 2000). Colton and Casper (2000) hypothesised that reduced intraglottal contact would cause reduced collision force. This in turn would decreased irritation caused by forceful intraglottal contact, and therefore support healing (Colton & Casper, 2000).

As previously mentioned, Confidential Voice technique is effective in the treating vocal nodules however the authors of the technique admit that it is not effective in the treatment of all hyperfunctional disorders. Thomas and Stemple (2007) stated that in some individuals the technique resulted in hyperfunction. Despite Thomas and Stemple (2007) reporting on this finding they failed to report on why this is so and which disorder presented in increased hyperfunction when employing this technique. This is a pity as it is evident from the explanation provided on nodules that an understanding of underlying pathophysiology and an understanding of how and why a technique works can assist the therapist in deciding if a technique is appropriate for a patient or not. This understanding is therefore hinged on evidence and speech therapy is a field that is moving towards being more evidence based in its approach (Roddam & Skeat, 2010).

Evidence based practice (EBP) is a framework of constructs and methods that originated in clinical medicine and has since been applied to a variety of fields from laboratory science to education (Dollaghan, 2004). EBP was defined by Sackett *et al.* (1996) as "… the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients… [by] integrating individual clinical expertise with the best available external clinical evidence from systematic research" (Sackett, Rosenberg, Gray, Haynes & Richardson, 1996, p.71). According to Dollaghan (2004) evidence based practice proposes an ethical method of addressing longstanding questions about clinical practice in communication disorders. The existing knowledge base available on clinical interventions is frequently incomplete, potentially incorrect and biased according to Dodd (2007). Clinical research that supports negative outcomes are often difficult to publish and systematic reviews are often biased by their inclusion and exclusion criteria used to include a study to the evidence base (Dodd, 2007). Consequently the results do not address some critical clinical questions (Dodd, 2007).

Dodd's (2007) third question is of particular relevance to the current study and forms the focus of the current research, i.e. when one is evaluating a particular intervention, *how* and *why* a communication behaviour changes and who are the individuals who will benefit from such an intervention? According to Dodd (2007) this is a question that often goes unanswered in studies evaluating the effectiveness of one treatment method verses another. Bernstein Ratner (2006) contends that to effectively evaluate an intervention in comparison to another, it is imperative that clinicians understand each treatment's *modus operandi* that is, *how* and *why* a particular therapy approach changes an individual's communication behaviour. This understanding empowers clinicians to formulate an intervention that is client specific (Dodd, 20007). In clinical practice, it has been my experience that often a treatment technique may be effective for one individual with a particular disorder and ineffective for another with the same disorder. It is therefore crucial to determine and understand how and why a treatment technique is either effective or ineffective for various individuals who share the same voice disorder.

The information gained from such a study would inform practice and result in more successful treatment of patients as the clinician would be able to estimate the potential effectiveness of the technique for a specific patient. It is envisioned that the present study will provide objective information on the question of *how* and *why* confidential voice technique works or may not work in the treatment of various hyperfunctional voice disorders.

METHODOLOGY

2.1. Aims

The primary aim of this study was to determine how the confidential voice therapy technique changed the voices of patients with hyperfunctional voice disorders physiologically, acoustically and in terms of air flow, as well as to assess the patients' perceptions of the technique and its effect on their voices.

The sub-aim of this study were:

1) To determine the relationship between patients' perceptions of the effects of the confidential voice therapy technique on their voices and the results obtained from objective voice evaluation i.e. acoustic analysis, aerodynamic measures and fiberoptic laryngeal examination.

2.2. Research Design

A quasi-experimental repeated pre-test post-test design was employed in this study. Quasi-experimental designs can be divided into two categories, non-equivalent group designs and interrupted time series designs (Marczyk, DeMatteo & Festinger, 2005). The current study employed a interrupted time series design. The reasoning behind a interrupted time series design involces comparing observations before and after the treatment or interuption (Heppner, Kivlighan & Wampold, 2008). If the treatment had an effect there would be a difference between the pre- and postintervention measures (Heppner, Kivlighan & Wampold, 2008).

This design was suitable for the current study as it allowed for the stroboscopy, aerodynamic and acoustic analysis results of the confidential voice therapy technique to be compared pre- and post-implementation and to determine the effect the technique (i.e. the treatment) had on individuals with hyperfunctional voice disorders. A repeated measures design was advantageous as it typically requires fewer participants (Gravetter & Wallnau, 2008). This is particularly relevant to the current study as the sample size was relatively small. Finally, the most advantageous aspect of repeated-measures design is that it reduces or eliminates problems caused by individual difference (Gravetter & Wallnau, 2008).

2.3. Participants

2.3.1 Sampling Method

Convenience sampling was employed. According to Gravetter and Forzano (2008) convenience sampling is the most commonly used sampling method in the behavioural sciences. This method of sampling makes use of individuals that the researcher has easy access to and who are both available and willing to participate in the research (Gravetter & Forzano, 2008). Convenience sampling is considered biased as the researcher does not make an attempt to know the population or utilise a random process in selection, hence it is considered a weak sampling technique (Gravetter & Forzano, 2008). The main disadvantage of convenience sampling however is that it has limited transferability of the results generated as they are context specific. Despite these shortcomings, there are instances where convenience sampling is the only way to collect the data (Weathington, Cunningham & Pittenger, 2010). Many good research studies have employed convenience sampling as a means of data collection, the specific results may be an artefact of the sample (Weathington, Cunningham & Pittenger, 2010). A body of knowledge that builds on pre-existing research is the growth of science, and this is particularly true for convenience samples as the results are viewed in light of the existing and future research (Weathington, Cunningham & Pittenger, 2010). Convenience sampling was deemed an appropriate method for the current study as the participants needed for the present study are those who attended an otolaryngology clinic for vocal pathology.

2.3.2 Sample size

The sample was twelve patients who presented with hyperfunctional voice disorders at The Voice and Swallowing Clinic at the Netcare Park Lane Hospital.

2.3.3 Inclusion criteria

In order to qualify as a participant for this study, individuals needed to have a hyperfunctional voice disorder as manifested in either: cysts, nodules, polyps, Reinkes's oedema, adductor spasmodic dysphonia or chronic laryngitis.

2.3.5 Exclusion criteria

Any individual who presented with a hypofunctional voice disorder, such as vocal fold paralysis or functional aphonia was excluded from this study.

3. Ethical Considerations

In accordance with ethical guidelines stipulated by the University of the Witwatersrand Human Research Ethics Committee (Medical) ethical clearance was obtained prior to the undertaking of this study. The researcher abided by the conditions of confidentiality, autonomy, non-maleficience and beneficence in the following ways:

- Autonomy: the proposed participants had freedom of choice in accepting the invitation to participate in the study.
- Beneficence and nonmaleficence: positive steps were taken to reduce and prevent participant harm, by clarifying and adhering to exclusion and inclusion criteria, and making participants completely aware of the procedures involved.

Participants were provided with an information letter detailing the purpose of the study, their role in the study and their rights (see appendix A). They were made aware that all information will be kept confidential. Upon reading the information letter, they were invited to participate in the study and informed consent was obtained (See appendix B). The participants were informed that they have the right to withdraw from the study at any time without negative consequences.

Personal names were replaced with codes to ensure that the patients remain anonymous. A separate file was opened for each patient, and all associated documentation relating to that patient was put into the file. All information was kept confidential and was only viewed by the researcher and supervisor. On completion of the study, all documentation and electronic data pertaining to the study has been kept in a locked cupboard in the speech pathology and audiology department, and will remain there for a period of five years.

2.3.4. Description of Participants

Twelve individuals with hyperfunctional voice disorders participated in this study.

Table 1 provides a summary of the number of participants in terms of age, gender, and vocal pathology.

Table 1: Description of Participants

	Male	**Female**
Total Number of Participants	5	7
Below 30 years old	3	4
Above 30 years old	2	3
Vocal Nodules	1	5
Polyps	1	1

Adductor spasmodic dysphonia	1	0
Intra-cordal cysts	0	1
Haemorrhage on cord	1	0
Post-op granuloma	1	0

Of the sample 5 participants (41.67%) were men and 7 participants (58.33%) were women.

The age of participants ranged from 13 years to 59 years with the majority (n = 5, 41.67%) of participants falling into the age range from 20-to-29 years. Other participants were distributed across the age ranges 10 years to 19 years (n=2, 16.67%); 30 years to 39 years (n= 1, 8.33%); 40 years to 49 years (n=1, 8.33%) and 50 years to 59 years (n=3, 25%). The mean age of the participants was 33.33 years. The mode is a statistical term for the number that occurs most frequently in a data set (Ott & Longnecker, 2010). The sample demonstrated a unimodal distribution with 29 years of age representing the mode.

Within the sample, 6 (50%) of the participants were documented to have vocal nodules; 2 (16.67%) had polyps; 1 (8.33%) participant had adductor spasmodic dysphonia, post-op granuloma, intra-cordal cyst and haemorrhage on cord respectively. According to Aronson and Bless (2009) there is limited incidence and prevalence data on voice disorders in otolaryngologic practices. One study of the prevalence of laryngeal pathologies in medical settings reported that vocal nodules were the most common vocal pathology (i.e. 21.6%) (Aronson & Bless, 2009). The data from the present study is therefore in agreement with the study reported by Aronson and Bless (2009).

4. Instrumentation and Measures

The following instrumentation and measures were used in the current study:

- Case history
- Transnasal flexible fiberoptic laryngeal examination with stroboscopy, analysed using the Stroboscopy Evaluation Rating Form (SERF) by Poburka (1999).
- Acoustic analysis using the Multi-Dimentional Voice Program Model 430 from KayPENTAX
- Aerodynamic measures using the Phonatory Aerodynamic System (PAS) Model 6600 from KayPENTAX

– Researcher–constructed Questionnaire on patients' perceptions of the confidential voice technique (Appendix D)

Case history

Patients completed a standard case history form (Appendix C) upon visiting the Netcare Park Lane voice clinic for their initial consultation with the otolaryngologist and speech therapist. The case history has been described as one of the most important aspects in the assessment of voice disorders (Robinson, 1993). The case history provides the clinician with clues to the possible cause of the voice disorder, the individual's predisposing and risk factors, as well as the onset and course of the disorder (Robinson, 1993).

Transnasal flexible fibre-optic laryngeal examination with stroboscopy

Flexible transnasal fiberoptic laryngoscopy is an easily administered examination of the larynx (Smith & Yanagisawa, 2009). It has been noted to have great value for diagnosis of functional and organic disorders (Smith & Yanagisawa, 2009). Respiration, phonation, glottal effort closure, connected speech, whistling, swallowing and velopharyngeal function can be studied effectively using the flexible laryngoscope (Smith & Yanagisawa, 2009). The information can be saved and printed for the patient's medical records and later analysis. If stroboscopy is added the clinician is able to visualise the mucosal wave in the steady or quasi-steady state of sustained vowel production (Smith & Yanagisawa, 2009). The stroboscopic exam was analysed using the Stroboscopy Evaluation Rating Form (SERF) by Poburka (1999) and thus the following were evaluated: amplitude of vibration, mucosal wave; non-vibrating portion; supraglottic activity; vocal fold edge smoothness; vocal fold edge straightness; vertical level; phase closure; phase symmetry and glottal closure. Table 2 includes the definitions of each parameter evaluated by the Stroboscopic Evaluation Rating Form (SERF).

Table 2: Definitions of the areas assessed using the SERF

Parameter	Definition
Amplitude	Horizontal excursion of the vocal folds and is an indication of the viscoelastic properties of the vocal fold (Song, 2013)
Mucosal wave	Pliability of the vocal folds and the larynx's ability to generate vibratory energy (Song,

	2013).
Non-vibrating portion	A portion of the vocal fold that does not vibrate that remains still during phonation. The absence of vibratory movement can occur either occasionally or always, and either partially or entirely (Hirano, 2009).
Supraglottic Activity	Supraglottic activity can be observed in two directions. The first is medio-lateral, in which the ventricular folds are forced medially towards the midline. The second type of supraglottic activity is in the antero-posterior direction. This type of compression is characterised by shortening of the aryepiglottic folds. This results in movement of the epiglottis posteriorly towards the arytenoids (Poburka, 1999).
Vocal Fold Edge Smoothness	The rater assesses the medial edge of the vocal fold for smoothness (Colton, Casper & Leonard, 2006)
Vocal Fold Edge Straightness	The rater assesses the medial edge of the vocal fold for straightness (Colton, Casper & Leonard, 2006)
Vertical level	The rater assesses whether or not the vocal folds are on-plane or off-plane during phonation (Poburka, 1999). On-plane vocal fold closure is considered normal, whereas off-plane vocal fold closure is considered abnormal.
Phase Closure	The rater assesses the relative duration of the open and closed phases of the vibratory cycle. Under normal vibratory conditions, the vocal cycle can be divided into 3 parts: (a) the opening part of the open phase

	(b) the closing part of the open phase (c) the closed phase The open phase is any portion of the cycle when there is a glottal space. The closed phase is any time the glottis is closed (Poburka, 1999).
Phase symmetry	The rater evaluates the amount of time the vocal folds are vibrating symmetrically (Poburka, 1999).
Glottal closure	The extent to which the vocal folds approximate each other (Colton, Casper & Leonard, 2006).

Acoustic measures

Woodson (1998) states that voice recording is a vital part of clinical management of vocal problems and is strongly recommended prior to commencing a therapeutic program. Another advantage of acoustic analysis recording is that the recording can be saved for future analysis, making this an effective clinical and research tool (Woodson, 1998). Acoustic analysis can be performed by having the individual phonate into a microphone which is fed directly into an analysis instrument that calculates a set battery of acoustic analysis (Woodson, 1998). The voice is then digitized for analysis using voice analysis software (Woodson, 1998). The acoustic signal of the individual's voice is a complex waveform, and all acoustic measures are effectively different types of waveform analysis (Woodson, 1998). Any complex waveform can be expressed mathematically as a computation of pure sine waves of changing frequency (Woodson, 1998). This facilitates the identification of the fundamental frequency and supplies spectral information, which has the potential to correlate with perceived differences in vocal quality (Woodson, 1998). Johnson and Jacobson (2007) report that acoustic analysis measures of voice production offer objective and non-invasive measures of vocal function.

Acoustic analysis is gaining popularity with voice pathologists as they are cost effective and a convenient indirect means to document voice status across time (Johnson & Jacobson, 2007). The participant is asked to read *The Rainbow* passage into a microphone that is connected to a computer with the voice analysis software programme. The Multi-Dimensional Voice Programme (MDVP) in addition with the

Computerised Speech Lab is a highly sophisticated and multipurpose voice processing and spectrographic analysis software programme (Campisi, Tewfik, Manoukian, Schloss, Pelland-Blais & Sadeghi, 2002). This software allows for objective, reproducible and non-invasive measure of vocal fold function (Campisi *et al.*, 2002). The MDVP has the potential to provide information on 33 acoustic variables from each voice analysis and compare them both graphically and numerically with a built-in normative database (Campisi *et al.*, 2002). For the purpose of this study the running speech analysis module was used. In this module all 33 acoustic variables are analysed. The following acoustic vocal parameters were measured and abbreviated as follows. Table 3 includes the definition and abbreviation of each parameter evaluated using the MDVP acoustic analysis program.

Table 3: Description of the acoustic parameters used in this study

Parameter	Definition
Average fundamental frequency (Fo)	The natural or most comfortable pitch produced by the larynx (Song, 2013). This is the average rate of vibration of the vocal folds (Stemple, Glaze & Gerdeman, 2000).
Mean fundamental frequency (MFo)	Mean rate of vibration of the vocal folds which is expressed in hertz (Stemple, Glaze & Gerdeman, 2000).
Average Pitch Period (To)	Average Pitch Period for all extracted pitch periods.
Highest fundamental frequency (Fhi)	Highest Fundemental Frequency for all extracted pitch periods.
Lowest fundamental frequency (Flo)	Lowest Fundemental Frequency for all extracted pitch periods.
Standard Deviation of Fo (STD)	This parameter provides the standard deviation of the fundamental frequency within the analyzed voice sample (Xue & Deliyski, 2001).
Phonatory Fo-Range in semi-tones (PFR)	This parameter is the range between the highest (Fhi) and the lowest (Flo) fundamental frequencies expressed in semitones. (Xue & Deliyski, 2001).

Fo-Tremor Frequency (Fftr)	Fo Tremor Frequency shows the frequency of the most intensive low frequency component in the specified range.
Amplitude Tremor Frequency (Fatr)	Amplitude Tremor Frequency shows the frequency of the most intensive low frequency component in the specified range.
Length of Analyzed Sample (Tsam)	The number of seconds recorded for analysis
Absolute Jitter (Jita)	Absolute jitter gives an evaluation of the period-to-period variability of the pitch period within the analysed vocie sample.
Jitter Percent (Jitt)	Jitter Percent gives an evaluation of the variability of the pitch period within the analysed voice sample. It represents the relative period-to-period (very short term) variability.
Relative Average Perturbation (RAP)	Frequency perturbation, or jitter, is a measure of the period of each cycle of vibration, subtracting it from the previous period, averaging the difference and dividing by the period. This result is multiplied by 100 in order to be expressed as a percent change of period relative to the average period and is referred to as the Relative Average Perturbation (RAP). Perturbation has been correlated with perceived hoarseness as individuals with voice dysfunction presenting with hoarseness are likely to exhibit a large amount of frequency and amplitude perturbation (Colton, Casper & Leonard, 2006).

Pitch Perturbation Quotient (PPQ)	This parameter provides an evaluation of the variability of the pitch period within the analyzed voice sample (Xue & Deliyski, 2001).
Smoothed Pitch Perturbation Quotient (sPPQ)	This parameter provides an evaluation of the short- or long-term variability of the pitch period within the analyzed voice sample. At high smoothing factors, sPPQ correlates with the magnitude of long-term frequency modulations of Fo (Xue & Deliyski, 2001).
Fundamental Frequency Variation (vFo)	This parameter represents the relative standard deviation of the period-to-period calculated fundamental frequency. It takes into account the very long-term variations of Fo for the entire analyzed voice sample (Xue & Deliyski, 2001).
Shimmer in dB (ShdB)	Shimmer in dB gives an evaluation of the period-to-period variability of the peak-to-peak amplitude within the analysed voice sample.
Shimmer Percent (Shim)	Shimmer percentage gives an evaluation of the variablity of the peak-to-peak amplitude within the analysed voice sample. It represents the relative period-to-period (very short term) variability of the peak-to-peak amplitude.
Amplitude Perturbation Quotient (APQ)	APQ provides an evaluation of the variability of the peak-to-peak amplitude within the analyzed voice sample (Xue & Deliyski, 2001).
Smoothed Ampl. Perturbation Quotient (sAPQ)	Smoothed amplitude perturbation quotient gives an evaluation of the short or long term variability of peak-to-peak amplitude within the analysed voice

	sample.
Peak-to-Peak Amplitude Variation (vAm)	Peak Amplitude Variation represents the relative standard deviation of the period-to-period calculated peak-to-peak amplitude. It reflects the very long term amplitude variations within the analysed voice sample.
Noise to Harmonic Ratio (NHR)	Noise-to-Harmonic Ratio is an average ratio of energy of the inharmonic components in the range 1500 – 4500Hz to the harmonic components energy in the range 70 – 4500Hz. It is a general evaluation of the noise presence in the analysed signal.
Voice Turbulence Index (VTI)	Voice turbulence index is an average ratio of the spectral inharmonic high frequency energy in the range 2800 – 5800Hz to the specral harmonic energery in the range 70 – 4500Hz in areas of the signal where the influence of the frequency and amplitude variations, voice breaks and sub-harmonic components are mininal. VTI acoustic parameter that illustrates the relative energy level of high-frequency noise present in the signal (Isozaki, 2005). This index is hypothesised to correlate with the turbulence caused by incomplete or loose adduction of the vocal folds (Isozaki, 2005).
Soft Phonation Index (SPI)	This parameter refers to an average ratio of the lower frequency harmonic energy (70 Hz–1600 Hz) to the higher frequency (1600 Hz–4500 Hz) harmonic energy. Increased SPI may be an indication of incomplete or loosely adducted vocal folds

	during phonation. SPI is very sensitive to the vowel formant structure because vowels with lower high-frequency energy result in higher SPI (Xue & Deliyski, 2001).
Fo-Tremor Intensity Index (FTRI)	Fo Tremor Intensity Index shows in percent the ratio of the frequency magnitude of the most intensive low frequency modulating component (Fo tremor) to the total frequency magnitude of the analysed voice signal.
Amplitude Tremor Intensity Index (ATRI)	Amplitude Tremor Intensity Index shows in percent the ration of the amplitude of the most intensive low frequency amplitude modulating component (amplitude tremor) to the total amplitude of the analysed voice sample.
Degree of Voice Breaks (DVB)	Degree of Voice Breaks shows in percent the ratio of the total length of areas representing voice breaks to the time of the complete voice sample.
Degree of Sub-harmonics (DSH)	Degree of sub-harmonics is an estimated relative evaluation of sub-harmonic to Fo components in the voice sample.
Degree of Voiceless (DUV)	Degree of voiceless is an estimated relative evaluation of nonharmonic areas (where Fo cannot be detected) in the vocie sample.
Number of Voice Breaks (NVB)	Number of Voice Breaks shows how many times the generated Fo was interrupted from the beginning of the first until the end of the last voiced area.
Number of Sub-harmonic Segments (NSH)	Number of Sub-Harmonic Segments found during analysis.
Number of Unvoiced Segments (NUV)	Number of Unvoiced Segments detected during the autocorrelation analysis.

Number of Segments Computed (SEG)	Total Number of Segments computed during the autocorrelation analysis.
Total Number Detected Pitch Periods (PER)	Pitch Periods detected during the period-to-period pitch extraction.

Aerodynamic measures

Aerodynamic measures are interpreted as the reflection of the valving activity of the larynx, representing both vocal fold configuration and movement, structure and function (Jacobson *et al*., 2007). Air flow and pressure can be measured under stable and transient speech productions (Jacobson *et al*., 2007). Average airflow rate or flow volume during sustained productions would reflect long-term or average aerodynamic measures (Jacobson *et al*., 2007). The running speech module was used to assess each participant with and without the use of confidential voice. The participant was required to read *The Rainbow* passage first using their normal speaking voice and secondly using the confidential voice. The signal was then analysed using all 10 parameters. The following aerodynamic parameters were measured and abbreviated as follows, Maximum SPL, Mean Pitch, Pitch Range, Phonation Time, Expiratory Airflow Duration, Inspiratory Airflow Duration, Peak Expiratory Airflow, Expiratory Volume, Peak Inspiratory Airflow, and Inspiratory Volume.

Table 4: Definitions of the aerodynamic parameters used in this study from KayPENTAX Instruction Manual (2009)

Parameter	Definition
Maximum SPL	The maximum sound pressure level value in the range.
Mean Pitch	The arithmetic mean pitch value taken from the voiced data in the range.
Pitch Range	The difference between the minimum and maximum pitch values in the range of data.
Phonation Time	The duration of voiced data in a range.
Expiratory Airflow Duration	The duration of positive airflow in the range. This is a measure of the total exhalation time.
Inspiratory Airflow Duration	The duration of the negative airflow in the range. This is a measure of the inhalation

	time.
Peak Expiratory Airflow	This measurement is specific to the Voicing Efficiency protocol. It is the largest air pressure values found in one or more air pressure bursts in a range of the Air Pressure contour.
Expiratory Volume	The total of all positive airflow samples in the range.
Peak Inspiratory Airflow	The maximum or peak negative rate of Airflow observed in the range.
Inspiratory Volume	The total of all negative Airflow samples in the range.

Patient questionnaire

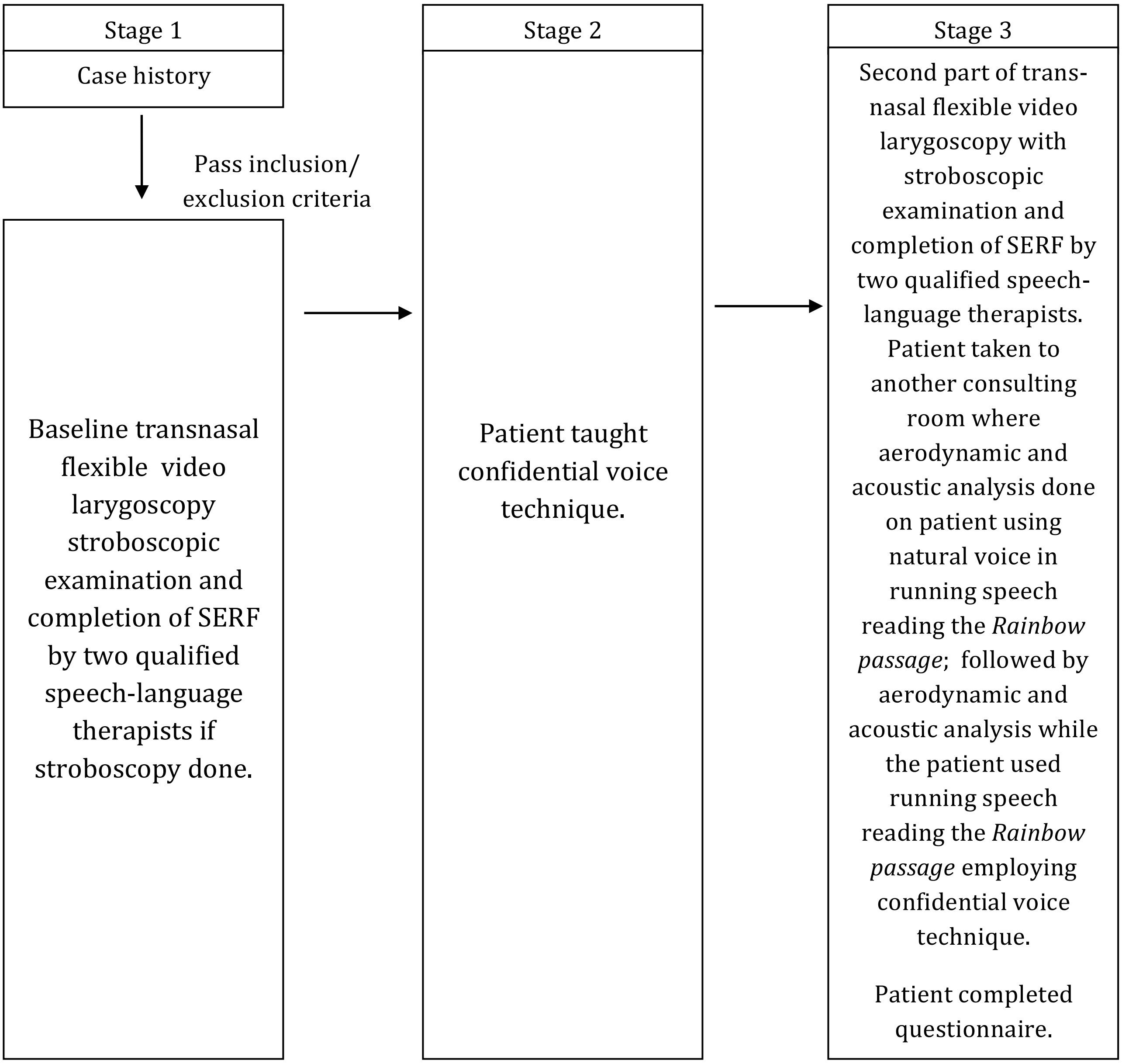
A self- constructed questionnaire was utilised to obtain information related to the participants' perceptions of the effect the confidential voice therapy technique has on their voices (Refer to Appendix D). According to Titler (2009), questionnaires are the most common tool in data collection**.** Questionnaires are cost-effective, quick to administer and convenient **(**Rahman, Usman, Warren & Athanasious, 2010). A disadvantage of questionnaires as a tool is that the participant cannot be prompted or aided during the completion stage if any difficulty is encountered with a question (Rahman *et al.,* 2010). However the researcher was present during the completion of the questionnaires to clarify any misunderstandings that arose. The participant completed the questionnaire once the confidential voice therapy technique had been demonstrated to them and they had tried to use it.

5. Procedure

As depicted in Flowchart 1, each participant first completed a case history information sheet provided by The Voice and Swallowing Clinic at Park Lane Hospital (Appendix C), followed by baseline flexible fibre-optic laryngeal examination with stroboscopy. The participant was then taught the confidential voice technique and asked to read the *Rainbow* passage in the confidential voice for the second half of the stroboscopic examination. The participant was then taken to a separate room where their voices were assessed using acoustic voice analysis and aerodynamic measures. The participant was asked to read the *rainbow* passage in their normal speaking voice followed by rereading in the confidential voice. Finally the participant was asked to complete a questionnaire on the confidential voice technique.

A qualified and experienced speech therapist, specialising in voice pathology, conducted the acoustic and aerodynamic measures. The results were matched to normative data provided by the programme and printed out. The ear, nose and throat surgeon at the Park Lane Voice clinic conducted the trans-nasal flexible fibre-optic laryngeal examination and stroboscopic examination. According to Smith, Nitz and Stuart (2006), incorporating baseline measures of the outcome variable into a study improves a risk-adjustment strategy for a number of reasons. Firstly, it ensures that all domains considered important for the particular outcome are included in the measures of initial severity. Secondly, since the baseline measure is identical to the final outcome measure, measurement error for that variable will be consistent across the initial and final time periods.

All results of the acoustic analyses and aerodynamic measures were analysed by the voice and air flow analysis software programmes from KayPentax Elemetrics Computerised Speech Lab Model 4500. The fibre-optic laryngeal examinations were evaluated by two qualified speech-language therapists. The results from the stroboscopic examination were analysed using the *Stroboscopy Evaluation Rating Form (SERF)* by Poburka (1999) by two speech therapists. By having two therapists evaluate every stroboscopic examination it is possible to ensure an accurate evaluation, i.e. the results are valid and reliable.



Flowchart 1: Data collection process

For the acoustic analysis portion of the recordings, the signal was recorded through a microphone which was held at a consistent distance of 10cm from the participant's mouth as determined by use of a ruler and at a 45^0 off-axis position to reduce aerodynamic noise from the mouth. For the aerodynamic measures the participant was asked to read the *Rainbow* passage into the facemask. The mask was held over the participant's nose and mouth area.

Thereafter each participant was assigned a code and all data was captured using a Microsoft Excel database. Gender, age and vocal pathology were also captured on the database. This therefore ensured anonymity and confidentiality of the participants' information. A data spreadsheet summarizing the information was then compiled using Microsoft Excel.

The data spreadsheet was compiled in a manner that was compatible with the SAS programme for statistical analysis. "WOCV" was used for with out confidential voice and "WCV" was used for with confidential voice. The measures were assigned the following codes displayed in brackets:

Table 5: List of parameters and the codes used in the SAS programme

Acoustic Analysis Parameter	**Aerodymanic Measures Parameter**
Average fundamental frequency (Fo)	Maximum SPL (MSPL)
Mean fundamental frequency (MFo)	Mean Pitch (MP)
Average Pitch Period (To)	Pitch Range (PR)
Highest fundamental frequency (Fhi)	Phonation Time (PT)
Lowest fundamental frequency (Flo)	Expiratory Airflow Duration (EAD)
Standard Deviation of Fo (STD)	Inspiratory Airflow Duration (IAD)
Phonatory Fo-Range in semi-tones (PFR)	Peak Expiratory Airflow (PEA)
Fo-Tremor Frequency (Fftr)	Expiratory Volume (EV)
Amplitude Tremor Frequency (Fatr)	Peak Inspiratory Airflow (PIA)
Length of Analyzed Sample (Tsam)	Inspiratory Volume (IV)
Absolute Jitter (Jita)	
Jitter Percent (Jitt)	
Relative Average Perturbation (RAP)	
Pitch Perturbation Quotient (PPQ)	
Smoothed Pitch Perturbation Quotient (sPPQ)	
Fundamental Frequency Variation (vFo)	
Shimmer in dB (ShdB)	
Shimmer Percent (Shim)	
Amplitude Perturbation Quotient (APQ)	
Smoothed Ampl. Perturbation Quotient (sAPQ)	
Peak-to-Peak Amplitude Variation (vAm)	
Noise to Harmonic Ratio (NHR)	
Voice Turbulence Index (VTI)	

Soft Phonation Index (SPI)
Fo-Tremor Intensity Index (FTRI)
Amplitude Tremor Intensity Index (ATRI)
Degree of Voice Breaks (DVB)
Degree of Sub-harmonics (DSH)
Degree of Voiceless (DUV)
Number of Voice Breaks (NVB)
Number of Sub-harmonic Segments (NSH)
Number of Unvoiced Segments (NUV)
Number of Segments Computed (SEG)
Total Number Detected Pitch Periods (PER)

Table 6: An example of the coding system employed in Microsoft Excel for capturing

Aerodymanic Measures

Parameter	wocv	wcv
Maximum SPL (MSPL)	82,39	73,07
Mean Pitch (MP)	204,56	185,65
Pitch Range (PR)	165,52	142,64
Phonation Time (PT)	20,68	15,39
Expiratory Airflow Duration (EAD)	26,59	22,67
Inspiratory Airflow Duration (IAD)	5,56	4,5
Peak Expiratory Airflow (PEA)	1,4	0,47
Expiratory Volume (EV)	4,82	1,97
Peak Inspiratory Airflow (PIA)	-2,44	-1,65
Inspiratory Volume (IV)	-4,95	-2,97

The data for each parameter for each participant was collated to find an average wcv and wocv value. The information was then analyzed using paired sample t-tests to establish if the readings were significantly different.

6. Data analysis

Once the data was reduced to two measures, i.e. wocv (without confidential voice) and wcv (with confidential voice), differences within the group across the 33 acoustic parameters and 12 aerodynamic measures were done using paired sample t-tests.
In order to determine whether confidential voice had a significant effect on the acoustic parameters of voice the wocv value was compared to the wcv value for each acoustic parameter using a paired sample t-test assuming equal variance.

In order to determine whether the confidential voice had a significant effect on the aerodynamic parameters of voice the wocv value was compared to the wcv value for each aerodynamic parameter using a paired sample t-test assuming equal variance.

In order to determine whether the confidential voice had an effect on the stroboscopic examination results of the voice the SERF was analyzed qualitatively using descriptive analysis.

In order to determine the perceptions of the participants the questionnaires were analyzed qualitatively using descriptive analysis.

RESULTS

The results are presented in accordance with the aims of the study. The results for the acoustic analysis will be presented first, followed by the aerodynamic measures, analysis of the questionnaire data and finally the stroboscopic examination ratings.

Acoustic Analysis Results

The raw data for each participant are captured in appendix E.

The overall result with respect to the acoustic analyses, was that confidential voice did not have a significant impact on the acoustic parameters. Table 7 below contains the with (wcv) and without (wocd) confidential voice means and standard deviations obtained by the whole group of participants on each acoustic parameter. The results of the paired sample t-tests comparing the without and with confidential voice values are shown in table 8.

Table 7: Mean values all acoustic parameters with and without confidential voice for the entire sample (n=12).

Parameter	Normative Values	Mean (without confidential voice)	Standard deviation (without confidential voice)	Mean (with confidential voice)	Standard deviation (with confidential voice)
Average fundamental frequency (Fo)	243.973	168,16	28,14	159.06	26,14
Mean fundamental frequency (MFo)	241.080	164,11	30,06	153,82	28,18
Average Pitch Period (To)	0.432	6,31	1,32	6,73	1,37
Highest fundamental frequency (Fhi)	252.724	305,77	142,25	281,76	113,38
Lowest fundamental frequency (Flo)	234.861	120,19	29,22	108,57	27,79

Standard Deviation of Fo (STD)	2.722	21,06	7,48	22,34	10,53
Phonatory Fo-Range in semi-tones (PFR)	2.250	16,17	9,04	17,08	7,83
Fo-Tremor Frequency (Fftr)	3.078	4,12	2,22	4,60	2,17
Amplitude Tremor Frequency (Fatr)	2.375	4,79	2,38	4,55	2,29
Length of Analyzed Sample (Tsam)	3.000	43,35	137,19	25,41	75,04
Absolute Jitter (Jita)	26.927	193,78	110,27	328,35	232,38
Jitter Percentage (Jitt)	0.633	3,33	1,05	4,93	2,54
Relative Average Perturbation (RAP)	0.378	2,03	0,78	2,92	1,48
Pitch Perturbation Quotient (PPQ)	0.366	3,11	3,33	3,60	2,06
Smoothed Pitch Perturbation Quotient (sPPQ)	0.532	6,28	4,34	9,02	7,20
Fundamental Frequency Variation (vFo)	1.149	11,40	5,94	11,05	6,21
Shimmer in dB (ShdB)	0.176	2,16	3,41	4,15	7,34
Shimmer Percent (Shim)	1.997	10,87	2,44	14,54	9,59
Amplitude Perturbation Quotient (APQ)	1.397	14,36	6,92	19,04	13,29
Smoothed Ampl. Perturbation Quotient (sAPQ)	2.371	29,02	5,12	28,23	12,66

Peak-to-Peak Amplitude Variation (vAm)	10.743	40,59	14,61	34,46	17,34
Noise to Harmonic Ratio (NHR)	0.112	0,22	0,06	3,56	11,43
Voice Turbulence Index (VTI)	0.046	2,35	6,56	2,98	8,98
Soft Phonation Index (SPI)	7.534	20,41	7,70	25,88	15,16
Fo-Tremor Intensity Index (FTRI)	0.304	8,43	18,79	12,37	25,47
Amplitude Tremor Intensity Index (ATRI)	2.658	8,80	4,10	7,26	2,95
Degree of Voice Breaks (DVB)	0.200	43,83	11,32	50,07	15,19
Degree of Sub-harmonics (DSH)	0.200	2,42	1,76	2,39	3,57
Degree of Voiceless (DUV)	0.200	46,37	16,71	44,20	21,02
Number of Voice Breaks (NVB)	0.200	15,00	23,69	22,92	34,32
Number of Sub-harmonic Segments (NSH)	0.200	11,58	35,42	21,67	47,84
Number of Unvoiced Segments (NUV)	0.200	68,08	21,11	80,83	62,43
Number of Segments Computed (SEG)	92.594	124,00	-	124,00	-
Total Number Detected Pitch Periods (PER)	713.188	317,36	64,72	289,90	76,23

Table 8: Results of the paired sample t-test comparisons between the without and with confidential voice acoustic measures.

	t values	Pr > t
Average fundamental frequency (Fo)	2,476	0,0308
Mean fundamental frequency (MFo)	4,808	0,0005
Average Pitch Period (To)	3,250	0,0077
Highest fundamental frequency (Fhi)	1,323	0,2128
Lowest fundamental frequency (Flo)	1,783	0,1022
Standard Deviation of Fo (STD)	0,439	0,6690
Phonatory Fo-Range in semi-tones (PFR)	0,542	0,5983
Fo-Tremor Frequency (Fftr)	0,562	0,5853
Amplitude Tremor Frequency (Fatr)	0,296	0,7727
Length of Analyzed Sample (Tsam)	0,383	0,7090
Absolute Jitter (Jita)	1,684	0,1202
Jitter Percent (Jitt)	2,005	0,0702
Relative Average Perturbation (RAP)	2,725	0,0197
Pitch Perturbation Quotient (PPQ)	0,821	0,4291
Smoothed Pitch Perturbation Quotient (sPPQ)	2,377	0,0367
Fundamental Frequency Variation (vFo)	0,243	0,8128

Shimmer in dB (ShdB)	1,547	0,1503
Shimmer Percent (Shim)	1,397	0,1898
Amplitude Perturbation Quotient (APQ)	1,762	0,1059
Smoothed Ampl. Perturbation Quotient (sAPQ)	0,183	0,8580
Peak-to-Peak Amplitude Variation (vAm)	1,372	0,1973
Noise to Harmonic Ratio (NHR)	1,008	0,3349
Voice Turbulence Index (VTI)	0,191	0,8523
Soft Phonation Index (SPI)	1,335	0,2088
Fo-Tremor Intensity Index (FTRI)	1,181	0,2626
Amplitude Tremor Intensity Index (ATRI)	1,351	0,2037
Degree of Voice Breaks (DVB)	2,027	0,0676
Degree of Sub-harmonics (DSH)	0,027	0,9790
Degree of Voiceless (DUV)	0,445	0,6647
Number of Voice Breaks (NVB)	1,389	0,1923
Number of Sub-harmonic Segments (NSH)	0,990	0,3437
Number of Unvoiced Segments (NUV)	0,647	0,5310
Number of Segments Computed (SEG)	Excluded	Excluded
Total Number Detected Pitch Periods (PER)	1,453	0,1801

As is evident in table 8 the differences between the acoustic analysis results of participants with and without confidential voice technique were only significant for Fundamental frequency; Mean fundamental frequency; Average Pitch Period; Relative Average Perturbation and Smoothed Pitch Perturbation Quotient. The remainder of the measures were not significantly different when the data for the whole group of participants was analyzed. These findings are in contrast to the expected effects of the confidential voice technique on the voice. There are a number of possible explanations for this finding, which are presented in the discussion.

Aerodynamic measures results

The raw data for each participant are recorded in appendix F.

The overall result was that confidential voice had a significant impact on the aerodynamic parameters. Table 9 below contains the without and with confidential voice means and standard deviations obtained by the whole group of participants on each aerodynamic parameter. The results of the paired sample t-tests comparing the without and with confidential voice values are shown in table 10.

Table 9: Mean values and standard deviations for all aerodynamic measures with and without confidential voice.

Parameter	Mean (without confidential voice)	Standard deviation (without confidential voice)	Mean (with confidential voice)	Standard deviation (with confidential voice)
Maximum SPL (MSPL)	80,65	3,80	73,72	3,43
Mean Pitch (MP)	172,31	30,68	162,61	31,75
Pitch Range (PR)	212,73	28,22	182,45	41,88
Phonation Time (PT)	18,31	3,83	12,99	2,39
Expiratory Airflow Duration (EAD)	14,79	12,94	16,32	11,83

Inspiratory Airflow Duration (IAD)	19,08	11,99	17,32	12,22
Peak Expiratory Airflow (PEA)	1,29	0,88	0,95	0,60
Expiratory Volume (EV)	3,36	2,12	3,07	1,77
Peak Inspiratory Airflow (PIA)	-1,59	0,93	-1,16	0,72
Inspiratory Volume (IV)	-6,03	6,39	-4,90	5,70

Table 10: Results of the paired sample t-test comparisons between the without and with confidential voice on aerodynamic measures

	t value	Pr > t
Maximum SPL (MSPL)	9,625	0,00
Mean Pitch (MP)	3,460	0,0053
Pitch Range (PR)	2,874	0,0151
Phonation Time (PT)	6,854	0,00
Expiratory Airflow Duration (EAD)	0,673	0,5150
Inspiratory Airflow Duration (IAD)	1,029	0,3257
Peak Expiratory Airflow (PEA)	2,169	0,0529
Expiratory Volume (EV)	0,826	0,4263
Peak Inspiratory Airflow (PIA)	3,070	0,0107
Inspiratory Volume (IV)	1,873	0,0905

As is evident in table 10 the differences between the aerodynamic results with and without the confidential voice technique were significant for Maximum SPL; Mean pitch; pitch range; phonation time and peak inspiratory airflow. The remainder of the measures were not significantly different when the data for the whole group of participants was analyzed. These findings are in contrast to the expected effects of the confidential voice technique on the voice. There are a number of possible explanations for this finding, which are presented in the discussion.

Self constructed questionnaire results

The questionnaires were analyzed descriptively. The questionnaire comprised of five questions. The first question was what the participants' understanding of confidential voice was.

The responses are recorded in Table 11 along side the participants' diagnoses.

Table 11: Responses of participants regarding their understanding of the Confidential Voice technique alongside their diagnoses

Diagnosis	Response
Post-op nodules	"To converse in a tone of voice that is not as harsh as my usual tone."
Post-op granuloma	"Speaking to someone privately without being overheard."
Nodules	"To not whisper but speak at a lower volume."
Hemorrhagic polyp	"Speaking softly in a breathy manner"
Slight hemorrhage on vocal cords	"Speaking with less force or loudness than one would usually use."
Post-op nodules	"It is not whispering however not loud either. The pitch is not loud and the emphasis is not stressed heavily on the words either."
Intra-cordal cysts	"Something I need to do more often. Not sure if I have the ability. But in short, almost like telling someone something you don't want the other people in the room to

	hear.”
Nodules	“It is talking softer so that there is less pressure on the vocal cords.”
Nodules	“Using your voice in a low, quiet tone, that makes it softer and less strained.”
Nodules	“To speak to someone so as no one close by could hear the conversation.”
Polyp	“Talking in a soft voice, so other people cant hear.”
Adductor spasmodic dysphonia	“A lower intensity of speech only audible to a close listener.”

As is evident from the table the majority of participants had a good understanding of what the technique entailed. However, the misconception that it was a speaking voice “so other people can’t hear” was apparent. The technique was explained as “a speaking voice that is softer and more breathy than an individual’s normal speaking voice”. The example used to illustrate it was “the speaking voice one would use when communicating something private to someone that you don’t want others to overhear”. This is still audible to a close listener but not to communication partners that are further away.

The second question asked was how the participants felt their voice changed when they employed the technique. The responses along with the participants’ diagnoses are documented in table 12.

Table 12: Responses of participants regarding how the participants felt their voices changed when employing the Confidential Voice technique alongside their diagnoses

Diagnosis	Response
Post-op nodules	“There is not as much pressure on my vocal cords.”
Post-op granuloma	“Softer and quieter”
Nodules	“More aware of breathing correctly and not speaking through the throat.”
Hemorrhagic polyp	“Lower pitch, less range, not as strong.”
Slight hemorrhage on vocal cords	“Less strain, less force on the throat.”

Post-op nodules	"More even tone"
Intra-cordal cysts	"Less strain"
Nodules	"It is much softer and easier to talk"
Nodules	"I feel that my voice is softer and its easier to use when I use the confidential voice technique."
Nodules	"It sounds lower"
Polyp	"It goes softer so it doesn't break when I talk. It feels more even."
Adductor spasmodic dysphonia	"The intensity and effort is less."

As is evident from the table above the majority of participants described their voices as "lower/softer/quieter" and "less strained".

The third question was whether they thought they could employ the technique in their everyday communication for the prescribed time period and to substantiate their answer. The responses are recorded in table 13 along with the participants' diagnoses.

Table 13: Responses of participants regarding whether the participant thought they could employ the Confidential Voice technique in their everyday communication for the prescribed time period alongside their diagnoses

Diagnosis	Response
Post-op nodules	"Yes"
Post-op granuloma	"Yes, if it meant improving vocal range."
Nodules	"Yes, it would be more difficult as I would have to concentrate but ultimately it would be beneficial."
Hemorrhagic polyp	"Yes, I can but its not fun."
Slight hemorrhage on vocal cords	"Yes"
Post-op nodules	"Yes, however would have to continuously be aware of being able to speak in the voice."
Intra-cordal cysts	"No, its against my natural personality."
Nodules	"No, it would be very difficult cause I am a very loud person and I really like to talk."

Nodules	"No, because you have to focus more when you talk and its hard to always remember to do that. And even when you do, its not comfortable when you're at school, there's noise and you want to talk to your friends normally."
Nodules	"Yes, I did but found it very difficult especially socially."
Polyp	"No, I would maybe forget sometimes."
Adductor spasmodic dysphonia	"No, I would forget as my personality is to be heard by all."

As is evident from the table above, half the participants felt they could use the technique in their everyday lives while the other half felt they could not as it would limit them.

The fourth question asked was what the participants perceived as the benefits and limitations of the technique. Their responses are tabulated in table 14 along with their diagnoses.

Table 14: Responses of participants regarding their perceived benefits and limitations of the Confidential Voice technique alongside their diagnoses

Diagnosis	Response
Post-op nodules	"To protect the vocal cords. I don't expect there should be any limitations."
Post-op granuloma	"Improvement in vocal range."
Nodules	"Benefits – more focused speaking and not harming my voice. Limits – volume and socially."
Hemorrhagic polyp	"Apparently limits voice strain"
Slight hemorrhage on vocal cords	"Using the technique lowers strain on the voice and allows the voice to rest and/or recover. Limitations: depending on circumstances, may not be applicable all the time."
Post-op nodules	"Being less harsh on the vocal cords."
Intra-cordal cysts	"It makes sense that I am doing harm at

	the moment and confidential voice could make a difference."
Nodules	"It will put less pressure on my vocal cords giving them time to rest and heal."
Nodules	"The benefits are that it will help your voice, make it easier to speak once you're used to it but its also sometimes hard to keep up on it all the time."
Nodules	"Not to put strain on the vocal cords."
Polyp	"Its so I don't strain my voice as much."
Adductor spasmodic dysphonia	"Less effort, but I may not be audible."

From the above it is evident that the participants perceived benefit from the technique in the form of "less strain/force" but found it limiting socially and that it required a level of concentration.

The fifth and final question was about the participants' understanding of why the technique was prescribed for their voice problem. Their responses are summarized in Table 15 along with their diagnosis.

Table 15: Responses of participants regarding their understanding of why the Confidential Voice technique was prescribed for their voice problem alongside their diagnoses

Diagnosis	Response
Post-op nodules	"To assist with the healing of the vocal cords."
Post-op granuloma	"To reduce pressure on the voice and to enable some relaxation on the vocal cords."
Nodules	"To preserve and not harm my voice."
Hemorrhagic polyp	"To limit impact of cords on each other during speech."
Slight hemorrhage on vocal cords	"To reduce pressure on the voice and allow it to rest."
Post-op nodules	"Because I am Afrikaans and I am very

	hard on my vocal cords."
Intra-cordal cysts	"Supposedly it should help the healing BUT practically in my everyday life I cant see myself 'behaving'. Yelling at dogs and kids? Its not possible… I'm not heard or listened to easily – I need to make more effort."
Nodules	"It will heal my voice quicker."
Nodules	"Because my voice is hoarse and strained and this technique will help this problem."
Nodules	"To let vocal cords heal after the op."
Polyp	"Its to make the bump on my vocal cords not get worse."
Adductor spasmodic dysphonia	"Reducing amount of effort and tension."

From the above table it is evident that for the most part the participants understood why the technique was recommended for their voice problem.

Stroboscopic Evaluation Rating Form (SERF) Results

The effects of confidential voice on the parameters described on the SERF were on the glottal closure patterns; mucosal wave; supraglottic activity and amplitude. The parameters that did not appear to be affected were non-vibrating portions; vocal fold straightness; vocal fold smoothness; vertical level; phase closure; phase symmetry or regularity.

Confidential voice resulted in reduced mucosal wave and amplitude, increase in open phase and a more incomplete glottal closure pattern. Table 16 documents the results for each participant's change in SERF results. (Appendix G)

DISCUSSION

The current research focused on providing evidence for the Confidential Voice technique in terms of its effects on the physiological, acoustic and aerodynamic properties of voice. Specifically the research attempted to address how the confidential voice technique alters the voice. The discussion aims to provide the reader with an understanding of the results of the study in conjunction with existing knowledge on the therapy technique. The discussion will discuss the results beginning with the acoustic analysis, followed by the aerodynamic measures, stroboscopic evaluation and patient perceptions of the technique. The results will be integrated and it is hoped that it will add to the existing knowledge base therefore providing an evidence base for the utilisation of the technique in hyperfunction voice disorders.

From the outset it should be noted that the small sample size is likely to have affected the results and the results may have been significant if the sample size was larger.

Acoustic Analysis

Acoustic analysis is a valuable tool for the voice therapist as it can detect changes in the voice that the ear cannot and can assist in early detection of negative voice changes that are perceptually undetectable (Shewell, 2013). Moreover the ear can be mistaken (Shewell, 2013). According to Baken and Orlikoff (2000), mere listening may not provide an awareness of the acoustic details that combine in order to produce a perception. This has implications for voice work decisions (Shewell, 2013). Johnson and Jacobson (2007) report that acoustic analysis measures of voice production offer objective and non-invasive measures of vocal function. Acoustic analysis is gaining popularity with voice pathologists as it is cost effective and a convenient indirect means to document voice status across time (Johnson & Jacobson, 2007). Previous work on the acoustic correlates of breathy vocal quality has identified three major features that predict perceptual ratings of breathiness, with varying degrees of success (Hillenbrand & Houde, 1996). The first is the amplitude of the first harmonic (H1); the second is the degree of signal periodicity, and thirdly spectral tilt (Hillenbrand & Houde, 1996).

The overall result of this study is that the Confidential Voice technique did not have a significant effect on the voices of the participants in terms of acoustics. The acoustic analysis results of participants with and without confidential voice technique were only significant for five out of the thirty-two parameters measured, namely fundamental frequency; mean fundamental frequency; Average Pitch Period; Relative Average Perturbation and Smoothed Pitch Perturbation Quotient.

Fundamental Frequency

Fundamental frequency is an acoustic parameter that directly reflects the vibratory rate of the vocal folds (Colton, Casper & Leonard, 2006). It is the component of the vocal fold tone with the lowest frequency or the frequency spacing between component frequencies (Colton, Casper & Leonard, 2006). The mean fundamental frequency is useful in the estimation of the appropriateness of frequency level for the patient's age and gender (Colton, Casper & Leonard, 2006). The vibratory frequency of an individual's vocal folds is determined by the length, tension and mass of the vocal folds (Colton, Casper & Leonard, 2006). The total vocal fold mass is not what is important but rather the portion of the vocal folds that are set in vibration as this has significance for diagnosis (Colton, Casper & Leonard, 2006). This vibration is determined by the fundamental frequency, intensity and mode of vibration (Colton, Casper & Leonard, 2006). The mass is further a function of the length of the vocal fold (Colton, Casper & Leonard, 2006). Research has shown that the length of the vibrating portion is decreased as the frequency is increased (Colton, Casper & Leonard, 2006). Frequency is said to decrease as the mass per unit length of the vocal folds increases (Colton, Casper & Leonard, 2006). Thirdly, the relationship between tension and the fundamental frequency is affected by changes in airflow (Colton, Capser & Leonard, 2006). Tension is said to raise the frequency as it is increased (Colton, Capser & Leonard, 2006). The results of the current study will be viewed in light of this information.

The fundamental frequency was significantly lower for the entire group of participants when employing the confidential voice technique (Pr>t = 0.0308), which would imply that the individuals were unable to simply decrease the intensity at which they spoke without reducing their fundamental frequency simultaneously. However, the fundamental frequency variation (vFo) measure was not significantly affected (Pr>t = 0.8128). The mean however was decreased when employing the Confidential Voice technique (vFo wcv mean = 11.05) as compared to the participants' normal phonation (vFo wocv mean = 11.40) and therefore in agreement with the reduction in fundamental frequency. By definition the fundamental frequency is responsible for the pitch we hear (Hewlett & Beck, 2013). It is the frequency with which a wave cycle repeats itself (Hewlett & Beck, 2013). This is the average rate of vibration of the vocal folds (Stemple, Glaze & Gerdeman, 2000). Therefore the average vibration of the vocal folds of the entire sample was significantly reduced when using the confidential voice technique. According to Marquardt and Matyear (2010) reduced vibration of the vocal folds yields a reduced pitch and vice versa. This is termed the aerodynamic myoelastic theory of vocal fold vibration. Tanner (2007) states that this is the principle of phonation. Both muscular and aerodynamic principles combine to create vocal fold vibration (Tanner, 2007). The muscular principles include elasticity of tissue and the movement of cartilages that adjust the position and tension of the vocal folds (Tanner, 2007). The vocal folds are blown apart and the elasticity is partially responsible for bringing the vocal folds back into the adducted position (Tanner, 2007). The aerodynamic forces that close the vocal folds are known as the Bernoulli principle (Tanner, 2007). Therefore a slightly abducted glottis allows for air to pass from below the vocal folds more easily yielding a reduction in vocal fold vibration and in turn a reduction in pitch. Moreover, the fundemental frequency mean (mean = 168.16Hz) when using normal phonation was noticeably decreased compared to the normative data (Fo = 243.973). This could be attributed to the presence of mass lesions, such as nodules, polyps and intracordal cysts, for as the mass of the vocal fold's vibrating portion increases the frequency at which it vibrates decreases (Colton, Casper & Leonard, 2006). Interestingly, all patients had lower fundamental frequencies when compared to the normative data which decreased further when employing the technique. However the raw data for the participant with adductor spasmodic dysphonia, revealed that the reading for the fundamental frequency was increased when employing the Confidential Voice technique compared to the reading taken using normal phonation. Adductor spasmodic dysphonia is a muscle tension disorder and therefore the tension in the participant's vocal folds is likely to be increased during phonation. According to Colton, Casper and Leonard (2006) as the tension increases the fundamental frequency increases. Therefore it is fair to assume that the tension in the vocal folds had increased yielding an increased fundamental frequency. This would imply that the technique increased this participant's tension rather than decreasing it. Therefore, perhaps this technique is counterproductive when working with patients with adductor spasmodic dysphonia.

The Average Pitch Period

A turbulent airflow pattern has been associated with breathy voice and is said to result in an acoustic signal that is less periodic than a non-breathy voice (Hillenbrand & Houde, 1996). Hillenbrand and Houde (1996) report that some investigators have reported strong correlations between breathiness ratings and the degree of signal periodicity (Klatt & Klatt, 1990; Hillenbrand, 1988; Hiltenbrand et al., 1994), whereas others have reported negative results (Bickley, 1982; Fischer-Jorgensen, 1967). The average pitch period when employing the confidential voice technique was significantly different from phonation without it (Pr > t = 0.0077) and therefore is in keeping with the results documented by Hillenbrand & Houde (1996) and others such as Klatt and Klatt (1990). The pitch period is defined as the time span between sequential openings of the glottis (Goldberg & Riek, 2000). Therefore the time span between sequential glottal openings is significantly increased when participants employed the confidential voice technique. This is supported by the hypothesised physiological changes that occur in the glottis by the developers of the Confidential Voice technique. The glottis is hypothesised to have a more open formation when employing the confidential voice technique. The more open formation of the glottis in turn would result in less vocal fold contact thereby resulting in a more breathy voice (Casper & Colton, 2000). The mean of the entire group when using phonation without the technique (mean = 6.31) was increased compared to the normative data (mean = 0.432) implying that the average time between sequential glottal openings is increased for disordered voices. The introduction of the Confidential Voice technique raised the mean further (mean = 6.73). The difference between phonation without and with the Confidential Voice was significantly higher (Pr>t = 0.0077). This would imply that the time between sequential glottal openings when employing the technique is significantly increased. This is not unexpected as the glottal formation pattern is altered when employing the technique to a more abducted position and therefore would increase the time span between sequential openings as the glottis is in a perpetually more open formation.

Perturbation Measures

Perturbation refers to the presence of cycle-to-cycle variability in the fundamental frequency, amplitude and waveform morphology during phonation (Aronson & Bless, 2009; Colton, Casper & Leonard, 2006). These changes indicate the slight changes in mass, tension, and biomechanical characteristics of the vocal folds, together with minor changes in neural control (Colton, Casper & Leonard, 2006). Perturbation is associated with perceived hoarseness or roughness in the voice and therefore in patients with vocal pathology roughness or hoarseness will manifest in increased frequency and amplitude perturbation (Colton, Casper & Leonard, 2006). Jitter, or frequency perturbation, is a measure of the cycle-to-cycle variability in the frequency of the signal (Aronson & Bless, 2009). Shimmer, or amplitude perturbation, is a measure of the cycle-to-cycle variability in the amplitude within a signal (Aronson & Bless, 2009). On a physiological level, the presence of perturbation in a vocal signal is an indication of some degree of irregularity in the vocal fold vibration (Aronson & Bless, 2009). A small degree of perturbation is considered normal. However an increase in the amount of perturbation in the voice signal is an indication of pathology (Aronson & Bless, 2009). Other measures of perturbation are Realtive Average Perturbation (RAP), Pitch Perturbation Quotient (PPQ) and Amplitude Perturbation Quotient (APQ).

Jitter

Jitter, or frequency perturbation, is a measure of the cycle-to-cycle variability in the frequency of the signal (Aronson & Bless, 2009). Jitter measures are concerned with short term variation, in other words, it is a measure of how much a given period differs from the period immediately following it (Baken & Orlikoff, 2000). The two parameters on the MDVP analysis that evaluate jitter (absolute jitter and jitter percentage) did not change significantly with the introduction of the Confidential Voice technique. The means when employing the technique, were however elevated (Jita wcv = 328.35; Jita wcv = 4.93) compared to the means without the technique (Jita wocv = 193.78; Jitt wocv = 3.33). Furthermore, the means for phonation without the technique (Jita wocv = 193.78; Jitt wocv = 3.33) were elevated in comparision with the normative data (Jita norm = 26.927; Jitt norm = 0.633). This is expected given that all the participants had disordered voices and therefore their phonation would display an increase in jitter measures. Jitter measures have been found to be increased by mechanical factors such as changes in mass and tissue properties of the vocal folds in the presence of vocal pathology, such as mass lesions (Baken & Orlikoff, 2000). In terms of the elevation in means when using the technique this could be attributed to the increase in airflow and decrease in vocal fold contact during phonation. Mathieson (2001) reports that during breathy phonation turbulant air is passed through the glottis simultaneously with the vocal note. Therefore, since turbulant air can be perceived as noise and noise is aperiodic (Stemple, Glaze & Gerdeman, 2000) it is understandable that the jitter values would be elevated. Awan (2001) reports that jitter values were elevated in breathy voices and therefore the results of the current study are in agreement with this.

Shimmer

Shimmer is also known as amplitude perturbation (Aronson & Bless, 2009). It refers to the small cycle-to-cycle changes in the amplitude of the vocal fold vibration. Shimmer reflects the kind and degree of pathology that a speaker may exhibit (Colton & Casper, 1990). Interestingly, the measures of amplitude perturbation from the speech signal emitted at the lips are determined not only by the vocal folds but also by the resonance characteristics of the vocal tract (Colton, Casper & Leonard, 2006). Therefore the measures of amplitude perturbation are likely a reflection of the joint effect of the vocal tract and the vocal folds (Colton, Casper & Leonard, 2006). The shimmer parameters evaluated in this study were not significantly different (Shimmer percentage Pr>t = 0.1898; shimmer in dB Pr>t = 0.1503) when employing the Confidential Voice technique. The means however were increased for the entire sample when employing the Confidential Voice technique (ShdB = 4.15; Shim = 14.54) when compared to the values for phonation without the technique (ShdB = 2.16; Shim = 10.87). Moreover the means for the shimmer measures of the participants' phonation without the technique were elevated when comparing them to the normative data (ShdB norm = 0.176; Shim norm = 1.997). This is not surprising as the voices of the participants were disordered and as previously mentioned shimmer values are an indication of the presence of vocal pathology. Moreover, the increase in shimmer readings when participants employed the technique is not unexpected and is in agreement with the results reported by Martin, Fitch and Wolfe (1995), who found that breathy voices presented with an increase in shimmer values.

Relative Average Perturbation (RAP)

Noise in the voice can arise either due to the vocal fold perturbation or to turbulence created by incomplete glottal closure during phonation (Owren & Bachorowski, 2007). Breathy phonation is usually a result of incomplete glottal closure, however noise does affect both jitter and shimmer (Owren & Bachorowski, 2007). Perturbation, as previously mentioned, generally means a deviation from an expected regularity in vocal fold vibration (Owren & Bachorowski, 2007). RAP is an estimate of jitter, or frequency perturbation, which is a measure of the period of each cycle of vibration, subtracting it from the previous period, averaging the difference and dividing by the period. This result is then multiplied by 100 in order to be expressed as a percent change of period relative to the average period and is referred to as the Relative Average Perturbation (RAP). Relative Average Perturbation has also been referred to as frequency perturbation quotient (Owren & Bachorowski, 2007). RAP has been said to be the most important jitter measure (Owren & Bachorowski, 2007). RAP is a measure of the period-to-period variability in pitch within the analyzed voice sample applying a smoothing factor of 3 (Palumbo *et al.*, 2010). In the current study the RAP values were significantly different (Pr>t = 0.0197) when the participants employed the Confidential Voice technique. This would imply that the variability between pitch periods is significantly different when employing the technique. Variation in pitch is dependent on length and tension of the vocal folds, which in turn affects vibration of the vocal folds (Smolover & Bertoli, 2006). Vibration of the vocal folds relies on their position, tension and airflow (Zsiga, 2012). In light of what has been discussed previously, the pitch of participants was lower when employing the technique. A lower pitch is as a result of a shortened vocal fold that has less tension and therefore slower vibration (Smolover & Bertoli, 2006). Breathy phonation for the most part results from a lessor degree of tension of the vocal folds and force by which they are held together (Wolraich, 2003). Therefore less laryngeal air pressure is required to keep the vocal folds in vibration (Wolraich, 2003). However, the mean RAP values when the participants employed the technique was increased (mean = 2.92) compared to the value during phonation without confidential voice (mean = 2.03). Moreover, the mean RAP during phonation without the technique was elevated in comparison to the normative data (norm = 0.378). This was expected as all participants had disordered voices and therefore presented with a greater degree of perturbation. Perturbation has been correlated with perceived hoarseness as individuals with voice dysfunction presenting with hoarseness are likely to exhibit a large amount of frequency and amplitude perturbation (Colton, Casper & Leonard, 2006). In light of this, the voices of the participants were more hoarse when employing the Confidential Voice technique as the perturbation measure was increased. Hoarseness is a vocal symptom that reflects aperiodic vibration of the vocal folds (Colton, Casper & Leonard, 2006).

<u>Smoothed Pitch Perturbation Quotient.</u>

Smoothed Pitch Perturbation Quotient provides an evaluation of the short- or long-term variability of the pitch period within the analyzed voice sample. At high smoothing factors, sPPQ correlates with the magnitude of long-term frequency modulations of Fo (Xue & Deliyski, 2001). The current study found that the sPPQ was significantly different when participants employed the Confidential Voice technique to when they did not. However, the Pitch Purturbation Quotient (PPQ) was not significantly different (Pr>t = 0.4291), but the mean was elevated when employing the Confidential Voice technique (mean = 3.60) as compared to phonation without (mean = 3.11). Moreover, the mean when using phonation without the technique was noticeably elevated from the normative data (norm = 0.366). Since PPQ is closely associated with jitter, it is understandable that the sPPQ would be affected. Jitter, as previously mentioned, is an evaluation of the short term period-to-period variation in pitch, whereas the sPPQ is a more long-term measure of variability. Therefore, based on the findings of the current study it would suggest that breathy voices are likely to have greater variability in the long term in terms of pitch in comparision to the short term variability of pitch.

<u>Amplitude Perturbation Quotient</u>

APQ provides an evaluation of the variability of the peak-to-peak amplitude within the analyzed voice sample (Xue & Deliyski, 2001). The current study found that the APQ was not signficantly different when participants employed the technique (Pr>t= 0.1059). The mean, however, was higher without the technique (APQ wocv mean = 14.36) than when the Confidential Voice technique was used (APQ wcv mean = 19.04). Furthermore, the Smoothed Aplitude Perturbation Quotient (sAPQ) was not significantly affected when participants utilised the technique (Pr>t = 0.8580). Similarly to APQ, the means for sAPQ were affected. The means for sAPQ were decreased when participants employed the Confidential Voice technique (sAPQ wcv mean = 28.23) compared to when they did not (sAPQ wocv mean = 29.02). These results would therefore suggest that there was greater variablity in amplitude in the short term when utilising the technique, however lesser variability in the long term. Breathy voices have been documented to have an increase in amplitude variability (Martin, Fitch & Wolfe, 1995).

Noise-to-Harmonic Ratio

Noise-to-Harmonic Ratio (NHR) is a ratio of periodic or harmonic signal energy to the aperiodic or noise energy in the voice waveform. It is derived from algorithms much like perturbation measures. The greater the signal or harmonic energy in an individual's voice the better the individual's voice quality (Stemple, Glaze & Gerdeman, 2000). Therefore the inverse is true, i.e. the greater the noise energy in an individual's voice the poorer the individual's voice quality. In situations where there is large noise energy, i.e. random aperiodicity in the vocal signal, abnormal vocal function is indicated (Stemple, Glaze & Gerdeman, 2000). This measure is considered to be of great comparative value across pre-treatment and post-treatment measures (Stemple, Glaze & Gerdeman, 2000). The results of the current study found no significant difference in NHR when participants employed the Confidential Voice technique. In an attempt to explain why this is so it is important to understand what the NHR is measuring and extrapolate a reason for why it would not be affected by the Confidential Voice technique. It is hypothesized that in a perfectly functioning larynx, adduction of the vocal folds would be complete during closed phase of phonation and the vibration of the mucosal waveform would yield a perfectly periodic sound signal (Carding & Mathieson, 2008). The sound that would be produced would contain solely a fundamental frequency and its harmonics, however in reality the human voice contains both periodic and aperiodic sound (Carding & Mathieson, 2008). Aperiodic sound or "noise" is a sound that is not a harmonic of the glottal signal (Carding & Mathieson, 2008). "Noise" in the larynx is usually caused by the air escape and irregular vibration (Carding & Mathieson, 2008). The more severe the noise in the signal the more hoarse the voice will sound (Carding & Mathieson, 2008). Therefore the NHR is an estimate of the degree of hoarseness in a voice (Carding & Mathieson, 2008). NHR provides an indication of the degree of hoarseness but not the cause (Carding & Mathieson, 2008). The NHR has been a popular indicator of dysphonic severity as well as of changes in vocal quality with treatment (Carding & Mathieson, 2008). It is therefore surprising that the NHR was not significantly different for patients when employing the Confidential Voice technique. Based on the hypothesized changes in the physiology of the vocal tract when employing the technique, there should have been a significant increase in the presence of noise in the voices of the patients, due to the increase in airflow when employing the technique. The mean value for NHR when employing the technique was found to be increased, but this increase was not significant. The majority of participants in the current study had vocal nodules and typically these individuals present with hoarseness as a symptom of the vocal pathology (Nicolosi, Harryman & Kresheck, 2004). Other participants had polyps, which too present with hoarseness as a symptom (Nicoloski, Harryman & Kresheck, 2004). One participant presented with adductor spasmodic dysphonia and individuals with adductor spasmodic dysphonia typically present with a component of hoarseness (Aronson & Bless, 2009). One participant presented with intracordal cysts, which have been found to have hoarseness as a vocal characteristic (Bansal, 2012). One of the participants presented with a hemorrhage on the vocal cord, which is a sign of vocal abuse and results in hoarseness (Bhattacharyya, 2009). The final participant was seen post-operatively for granuloma. Typically, post- operatively patients present with slightly more breathy and hoarse voices immediately following surgery. However breathiness and hoarseness may persist and regarded as a successful result (Aronson & Bless, 2009). Based on the vocal pathologies that the participants in this study presented with, each of them should have had hoarseness as a component of their vocal pathology and therefore the NHR should have been significantly different. Perhaps the small sample size contributed to the lack of significance when comparing the NHR mean with and without the technique.

Voice Turbulence Index

Voice turbulence index (VTI) is an acoustic parameter that illustrates the relative energy level of high-frequency noise present in the signal (Isozaki, 2005). Hillenbrand and Houde (1996) stated that high frequency energy is increased in breathy signals. VTI is hypothesized to correlate with the turbulence caused by incomplete or loose adduction of the vocal folds (Isozaki, 2005). Based on the hypothesized anatomy by Isozaki (2005), loosely adducted vocal folds or incomplete vocal fold adduction is the glottal closure pattern when individuals employ the Confidential Voice technique. Therefore this parameter should have been significantly affected in the current study. However this is not the case. The mean for VTI when employing Confidential Voice was increased in comparison to when the participants did not use the technique but not significantly so. Perhaps this parameter was not significant because not all the participants consistently used incomplete glottal closure when employing the Confidential Voice technique. When evaluating the raw data, half of the participants were recorded as having an increase in the VTI when employing the Confidential Voice technique, but the other half had a decrease in the VTI measure when employing the technique. The participants who demonstrated an increase in the VTI when employing the Confidential Voice had a variety of diagnoses namely, nodules, polyps and post-operative granuloma. The majority however were individuals with vocal nodules. Therefore, based on the pathophysiology of vocal nodules, it is known that these individuals present with hourglass glottal closure, which in turn results in a breathy quality of voice. Therefore it is not unexpected that these individuals would present with an increase in VTI readings. However, not all participants who had the diagnosis of vocal nodules presented with increased VTI readings when employing the technique. In these instances perhaps this is due to an understanding of the technique and how to effectively employ it. Interestingly, the participant who had the diagnosis of adductor spasmodic dysphonia had a visibly reduced VTI reading when employing the Confidential Voice technique. This would mean that the amount of high frequency energy in the signal recorded was reduced rather than increased, as one would expect for employing the Confidential Voice technique. In an effort to understand why this may be so the pathophysiology of adductor spasmodic dysphonia will briefly be discussed. Spasmodic dysphonia is a focal laryngeal dystonia, which involves spasmodic contractions of the intrinsic musculature (Blitzer & Meyer, 2006). If these contractions involve the adductor musculature it is then referred to as adductor spasmodic dysphonia and is characterized by a harsh, strained and strangled quality with voice breaks (Blitzer & Meyer, 2006). The exact pathophysiology of this disorder is largely unknown, however the current theory is that the site of pathology is the basal ganglia (Blitzer & Meyer, 2006). Typically, voice therapy techniques used in the treatment of adductor spasmodic dysphonia include the use of increased pitch, increased breathy quality which would include the use of Confidential Voice, use of easy voice onset using /h/ and relaxation training (Stemple, 2000). However, these patients usually require medical intervention in the form of

Botox injections in addition to voice therapy (Stemple, 2000). However, based on the results from the current study the use of the Confidential Voice technique for patients with adductor spasmodic dysphonia does not have the desired effect and therefore its use for these patients should possibly be rethought.

<u>Soft Phonation Index</u>

Soft Phonation Index (SPI) is an evaluation of the weakness of the high frequency harmonic components, which may be an indication of loosely adducted vocal folds during phonation (Mathew & Baht, 2009). It reflects a ratio of low frequency harmonic energy to high frequency harmonic energy for voiced areas in a sample (Mathew & Baht, 2009). Factors that have been found to affect SPI are the rigidity of the vocal tract walls; vocal source and weaker or less complete vocal fold closure (Mathew & Baht, 2009). An elevated SPI value is thought to indicate incomplete vocal fold adduction (Mathew & Baht, 2009). Other studies have documented an increased SPI value in breathy as well as pressed voices (Mathew & Baht, 2009). Interestingly this parameter was not found to be significantly different (Pr>t = 0.2088) when the participants did and did not employ confidential voice technique in the current study. This is in contrast to what was expected given that the Confidential Voice technique has been hypothesized to produce a more open glottal closure pattern resulting in breathy phonation (Casper & Colton, 2000). Therefore the results of the current study are not in agreement with the results documented by other authors. However, the mean of the SPI during phonation without the technique (mean = 20.41) was elevated compared to the normative data (mean = 7.534) and further elevated in the participants when employing the technique (mean = 25.88). When looking at the raw data, all the participants with the exception of two participants with nodules and the participant with adductor spasmodic dysphonia, showed an increase in SPI when employing the Confidential Voice technique. This is in keeping with the findings of Mathew & Bhat, 2009). Interestingly, Mathew and Bhat (2009) report that SPI is sensitive to changes affecting vocal fold closure in unilateral vocal nodules (Mathew & Bhat, 2009). Perhaps the reason why the two participants in the current study who presented with a decline in SPI when employing the technique can be attributed to the fact that they had more complete glottal closure. The individual who presented with adductor spasmodic dysphonia was an outlier for this parameter as the reading for SPI on phonation without the technique (SPI wocv = 6.763) was lower than the normative data (norm= 7.534). Moreover the SPI measure was decreased further when the participant employed the technique (SPI wcv = 3.25). This could be attributed to the fact that individuals with adductor spasmodic dysphonia present with vocal folds that are often tightly closed during phonation resulting in a hoarse, strained, strangled voice quality (Roth & Worthington, 2010). The introduction of the technique however reduced the SPI reading further which would imply that the vocal fold closure was even tighter upon employing the technique. Therefore, perhaps this technique has the opposite effect on individuals with adductor spasmodic dysphonia, in that it increases hyperfunctional behavior rather than reducing it.

Degree and Number of Voice Breaks

The degree of voice breaks (DVB) as well as the number of voice breaks were other parameters that were not significantly affected by the introduction of the technique in this study. DVB is defined as the percentage of voice breaks in the sample. Voice breaks are typically phonation or pitch breaks. Pitch breaks are defined as abrupt breaks in phonation that may involve the upward or downward shift in vocal register or a momentary voice stoppage (Roeser, Pearson & Tobey, 1998). In the case of mass lesions, pitch and phonation breaks may occur in the upper end of the pitch range and flexibility in pitch and volume change may be noted (Tucker, 1993). This parameter was found to not be significantly different (Pr>t = 0.0676) with the introduction of the Confidential Voice technique. However the mean DVB when employing the Confidential Voice technique (mean = 50.07) was increased in comparison to the mean DVB without the technique (mean = 43.83). The mean DVB when the participants did not employ confidential voice (mean = 43.83) was elevated in comparison to the normative data (mean = 0.200). Moreover, the mean for number of voice breaks was also not significant (Pr>t = 0.1923) when comparing phonation with and without the Confidential Voice technique. However, the mean degree of voice breaks without confidential voice was elevated (mean = 15.00) compared to the normative data (NVB = 0.200). The mean was further elevated when employing the Confidential Voice technique (mean = 22.92). Therefore this would imply that the degree of voice breaks was noticeably increased in relation to the normative value for all the participants in the current study. This is expected as all participants in the current study had a voice pathology, the majority of which were mass lesions. When examining the raw data, three of the participants had lowered DVB readings when employing the technique, however the remaining nine participants had an increase in DVB when employing the Confidential Voice technique. The individual with adductor spasmodic dysphonia had readings that were remarkably elevated in relation to the normative data. Phonation breaks are most often associated with excessive laryngeal tension (Gallena, 2007). Laryngeal tension is a core characteristic of adductor spasmodic dysphonia and therefore the increase in voice breaks is expected. However the increase in phonation breaks when employing the Confidential Voice technique is unexpected. Confidential Voice technique is hypothesized to produce an incomplete glottal closure pattern which results in increased airflow (Casper & Colton, 2000) with reduced vocal contact and subglottal pressure. The decrease in subglottic pressure possibly accounts for the increase in vocal breaks as the vocal fold tension is reduced, resulting in a reduced ability to sustain phonation. When examining the raw data, three out of the twelve participants presented with a reduction in the number of voice breaks when employing the confidential voice technique, however the remaining nine participants presented with an increase in the number of voice breaks when employing the technique and is likely due to the same reasons as those hypothesized for the DVB.

Degree and number of sub-harmonics

The Degree of sub-harmonics is an estimated relative evaluation of sub-harmonic to Fo components in the voice sample. This parameter was not significant when phonation with and without Confidential Voice (Pr>t = 0.3437). The means, however, were noticeably decreased when employing the Confidential Voice technique (DSH wcv = 2.39; DSH wocv = 2.42). This would imply that the number of sub-harmonics was reduced in the voices of participants when employing the technique. Subharmonics have been linked to roughness in vocal quality by other researchers (Tsai, 2004) and therefore the reduction in the degree of subharmonics when employing the technique is a favourable result. However the mean value for the number of subharmonic segments (NUV) was increased when employing the technique (NUV wcv mean = 21.67) as compared to when the participants did not use the technique (NUV wocv mean = 11.58). However the difference between these was not significant (Pr>t = 0.5310). This is therefore in contrast to DSH results. Therefore this would suggest that the number of subharmonic segments is increased in the voices of participants when employing the technique, however the degree is lessened.

Frequency Tremor Intensity Index, Fundamental Frequency and Amplitude Tremor Frequency

Tremor can be defined on a physiological level as an involuntary periodic oscillation of a body part (MacCallum, Zhang & Jiang, 2009). Patients with vocal tremor typically have difficulty producing a voluntarily steady, sustained phonation and may complain of a shaky voice (MacCallum, Zhang & Jiang, 2009). In severe cases such as in spasmodic dysphonia, tremor may result in abrupt stoppage of voice (MacCallum, Zhang & Jiang, 2009). All three measures used to assess tremor were found not to be significantly affected by the introduction of the technique (Fftr Pr>t = 0.5853; Fatr Pr>t = 0.7727; FTRI Pr>t = 0.2626). The means however were affected. In terms of Fftr, the mean was elevated when employing the technique (Fftr wcv mean = 4.60). This would suggest that there was an increase in the fundamental frequency tremor however this was not significant. Secondly, in terms of Fatr the mean was decreased when employing the technique (Fatr wcv mean = 4.55). This would imply that the frequency of amplitude tremor was reduced when employing the technique however not significantly so. Finally, the mean for FTRI was increased when employing the Confidential Voice technique (FTRI wcv mean = 12.37). This would mean that the fundamental frequency tremor intensity was increased when using the technique, however again, not significantly so.

Aerodynamic Measures

Normal speech production relies on appropriate respiration and speech breathing (Mathieson, 2001). Respiratory disorders may be the primary cause of voice disorder. However poor speech-breathing may be as a result of a laryngeal valving disorder (Mathieson, 2001). Therefore objective measures allow for clarification and quantification of the efficacy of respiration (Mathieson, 2001). The value of aerodynamic measures is in monitoring the changes as a result of treatment rather than assisting with diagnoses (Mathieson, 2001). Aerodynamic measures of voice include measures of air volume (i.e. vital capacity and tidal volume), airflow for example peak glottal airflow, and subglottal pressure (Morris & Harmon, 2010).

In terms of the aerodynamic measures used in this study, half of the parameters were found to differ significantly when comparing phonation with and without confidential voice while the other half did not. The significant aerodynamic parameters included Maximum SPL, Maximum Pitch, Pitch Range, Phonation Time and Peak Inspiratory Airflow, whereas the non-significant variables were Expiratory Airflow Duration (EAD), Inspiratory Airflow Duration (IAD), Peak Expiratory Airflow (PEA), Expiratory Volume (EV) and Inspiratory Volume (IV).

In an effort to explain why these parameters were not significant it is important to understand what each of these parameters measured. Both inspiratory and expiratory airflow duration are measures of time taken for airflow to change positions, distingued only by directionality. In normal breathing, the relative durations of inhalation and exhalation are equal (Garn-Nunn & Lynn, 2004). But in speaking, the expiration in a single respiratory cycle is approximately ten times that of the inspiratory cycle (Garn-Nunn & Lynn, 2004). Despite the differences between the inspiratory and expiratory cycle length for speech the amount of air exchanged is approximately equal (Garn-Nunn & Lynn, 2004) but the time taken is the changing variable. If the expiration cycle is ten times longer than that of the inspirtory cycle for normal speaking, surely the expiration for the breathy phonation would be larger as the amount of air that escapes during breathy phonation is hypothesised to be larger than that for normal phonation. However this study did not find evidence of this. This study revealed no significant difference between the expiratory airflow duration on speaking with and without confidential voice. This is despite the hypothesised anatomical changes that occur when employing the technique. The glottis is more open which should yield greater/faster escape of air during phonation, yielding shorter utterances. However, interestingly, there is no significant difference between speech with and without confidential voice. Could it be that confidential voice does not yield a significantly more open glottis?

Expiratory and inspiratory volume are measures of volume, differentiated by directionality. Volume can be defined as the three dimensional amount of air either present or displaced within a system (Aronson & Bless, 2007). Expiratory volume and inspiratory volume are for the most part equal no matter the speech act (Garn-Nunn & Lynn, 2004). Therefore it is not surprising that the results for speech with and without confidential voice were not significantly different as the volume of air available for phonation is the same in both conditions. However, although the amount of air that is utilised is equal, the time taken for the air to be utilised may vary.

Peak expiratory airflow is defined as the largest air pressure values found in one or more air pressure bursts in a range of the Air Pressure contour (PAS manual, 2009). This parameter was also found not to be significant ($Pr>t = 0.0529$) between speech with and without the confidential voice technique. According to Davidson (2004), breathy phonation results from a force that is too weak to cause complete adduction of the vocal folds. The subglottal air pressure is low and air consumption is high, however the level of sound produced is low (Davidson, 2004). Therefore, it was hypothesised that the confidential voice technique would affect the peak expiratory airflow. However based on the results it would appear that there was no significant change in the largest air pressure value between the two voices. Moreover, the mean for peak expiratory airflow was reduced when participants employed the confidential voice technique (PEA wcv = 0.95) compared to when they did not (PEA wocv = 1.29). This would imply that the air pressure was reduced, albeit not significantly, when employing the technique.

Peak Inspiratory Airflow (PIA) is defined as the maximum or peak negative rate of Airflow observed in the range (PAS Manual, 2009). In the current study this parameter was found to be significantly different (Pr>t = 0.0107) when participants employed the Confidential Voice. This would imply that the maximum negative airflow was significantly different when employing the technique. The mean was increased when employing the Confidentail Voice technique (PIA wcv mean = -1.16) compared to the participants' phonation without the technique (PIA wocv mean = -1.59). Therefore it would appear that the rate at which the participants inhaled was greater for Confidential Voice as compared to their phonation without the technique. According to Mathieson (2001), inspiration is influenced by the type and length of the anticipated utterance. Perhaps the PIA was increased for Confidential Voice as the participants required more air in order to complete the utterance due to increased air expenditure for breathy phonation compared to normal phonation.

Phonation time can be defined as the duration of voiced data in a range (PAS Manual, 2009) or the amount of time the vocal folds are vibrating in a speech sample. In the current study the phonation time was significantly different (Pr>t = 0.00) when participants utilised the Confidential Voice compared to when they did not. Additionally, the mean for Confidential Voice (PT wcv mean = 12.99) was decreased in comparison to the mean for phonation without confidential voice (PT wocv mean = 18.31). This would imply that the phonation time was signficantly reduced when employing the Confidential Voice technique. This is an expected result given that the technique uses more air than normal phonation because air is expired at a more rapid rate with a more open glottal closure pattern resulting in shorter utterances (Colton, Capser & Leonard, 2006).

Pitch range (PR) can be defined as the difference between the minimum and maximum pitch values in the range of data (PAS Manual, 2009). This parameter was found to be significantly different (Pr>t = 0.0151) when the participants used the Confidential Voice. In terms of the mean values, the mean for the entire group when using the Confidentail Voice technique (PR wcv mean = 182.45) was remarkably reduced as compared to the mean for the participants' phonation without confidential voice (PR wocv mean = 212.73). Therefore the difference between the minimum and maximum pitch values in the sample was reduced for the Confidential Voice technique. This is understandable based on the anatomy and physiology of the technique. Variation in pitch is dependent on length and tension of the vocal folds, which in turn affects vibration of the vocal folds (Smolover & Bertoli, 2006). Breathy phonation for the most part results from a lessor degree of tension of the vocal folds and force by which they are held together (Wolraich, 2003) thereby limiting the pitch range of the voice. Therefore it is not surprising that the difference between the mean pitch (MP) for Confidential Voice was significantly different to that when the technique is not used (Pr>t = 0.0053). Moreover the mean for mean pitch (MP wcv mean = 162.61) was lower during confidential voice than phonation without (MP wocv mean = 172.31). This finding is in agreement with that by Smolover & Bertoli (2006) who reported a lower pitch as a result of a shortened vocal fold that has less tension and therefore slower vibration.

The maximum SPL was found to be significantly different (Pr>t = 0.00) between speech with and without confidential voice. The maximum SPL is defined as the maximum sound pressure value in the range (PAS Manual, 2009). Therefore it stands to reason that the maximum sound pressure required for phonation without confidential voice is significantly larger than that required for confidential voice based entirely on the anatomy requried to produce the two voices. Confidential voice is softer as a result of decreased contact of the vocal folds and therefore the amount of pressure required to produce it would be less than that required for normal phonation. It is also important to bear in mind that the technique is generally prescribed for hyperfunctional voice users and therefore their normal speaking voices are likely to have a greater maximum SPL prior to the introduction of the technique. Moreover, the mean was visibly reduced when employing the Confidential Voice technique (MSPL wcv mean = 73.72; MSPL wocv mean = 80.65).

Stroboscopy

Laryngeal videostroboscopy has been considered the golden standard in the evaluation of laryngeal structure and function during voicing (Stemple & Rey, 2010). The Stroboscopic Evaluation Recording Form by Poburka (1999) was used to document the parameters evaluated by the stroboscopy. The results of the stroboscopic examinations were analysed using descriptive analysis. The parameters that were noticeably affected by the Confidential Voice technique were glottal closure patterns; mucosal wave; supraglottic activity; phase closure and amplitude. The parameters that did not appear to be affected were non-vibrating portions; vocal fold straightness; vocal fold smoothness; vertical level; phase symmetry or regularity. The parameters that were affected will be discussed first followed by the other parameters that appeared not to be affected.

Glottal Closure

Glottal closure was the first parameter that was noticeably different when employing the confidential voice technique. The glottal closure patterns for the participants were more open when employing the confidential voice technique. The glottal closure patterns for the individuals who had vocal nodules varied prior to the use of the technique, when they revealed either a posterior gap or hourglass closure. When patients employed the technique those who initially presented with hourglass closure maintained this closure pattern, whereas those who had initially presented with a posterior gap closure pattern presented with incomplete glottal closure patterns. This is in keeping with what has been documented as closure patterns of vocal folds affected by vocal nodules (Gallena, 2007). Gallena (2007) states that it is this closure pattern that leads to the breathy voice quality that these patients typically present with.

The one individual, who presented with polyps, initially presented with a hourglass glottal closure pattern that was unchanged by the introduction of the technique. This is in contrast with other findings by other researchers such as Mathieson (2001), who stated that individuals who present with vocal polyps have an incomplete glottal closure pattern as a result of the obstruction caused by the polyp. While vocal nodules are always bilateral and symmetrical and therefore result in hourglass glottal closure (Johns & Parikh, 2009), vocal fold polyps are more commonly unilateral, however can occur bilaterally (Johns & Parikh, 2009). Therefore, if a patient presented with bilateral polyps then it is not surprising that an hourglass closure pattern would be evident. Incomplete glottal closure is therefore associated with a unilateral vocal fold lesion (Murdoch, 1998). The voice quality of individuals who have the diagnosis of vocal polyps typically present with breathy, rough sounding voices (Mathieson, 2001) similar to that of vocal nodules. A possible explanation for the difference in closure patterns noted in the current study and that of Mathieson (2001) is that the patient in the current study had bilateral polyps resulting in the hourglass closure pattern as apposed to a unilateral lesion presenting with incomplete glottal closure. A second participant was initially diagnosed with a hemorrhagic polyp, however when he participated in the current study he had had corrective surgery and therefore it is not surprising that he presented with complete glottal closure when using phonation without confidential voice and incomplete glottal closure when employing the technique. This participant's voice was functioning within normal limits and therefore had been prescribed the technique as a post-operative measure to allows for lesions to heal in the absence of continued vocally traumatic phonation.

One of the participants presented with intracordal cysts and was found to have hourglass glottal closure when using normal phonation as well as when employing the technique. Intracordal cysts are often found in the middle third of the vocal fold (Warner, Corbridge, Thirlwall, Patel & Martinez-Devesa, 2009) much like vocal nodules which are commonly associated with this glottal closure pattern. They are often unilateral and mistaken for early nodules (Colton, Casper & Leonard, 2009). In a study by Colton, Woo, Brewer, Griffin and Casper (1995) the patients presenting with intracordal cysts had one of three glottal closure patterns, the majority had hourglass glottal closure patterns, followed by posterior chink pattern and lastly complete closure. Therefore the result from the current study is in keeping with these findings.

The participant with adductor spasmodic dysphonia presented with complete glottal closure when using normal phonation which changed to incomplete glottal closure when employing the technique. In terms of the pathophysiology adductor spasmodic dysphonia is a focal dystonia that is characterised by involuntary spasms of the vocal folds or laryngeal musulature, it results in the individual's voice sounding hoarse, strained and staccato (Roth & Worthington, 2010). It is often characterised by voice and pitch breaks (Roth & Worthington, 2010). Treatment often involves the use of botox in conjunction with voice therapy (Roth & Worthington, 2010). Therfore it was expected that the individual would present with complete glottal closure when using normal phonation as the pathophysiology of the disorder results in the vocal folds being adducted tightly by spasms (Roth & Worthington, 2010). Therefore the introduction of the Confidential Voice allowed for the introduction of easy voice onset similar to that experienced when using /h/ at the onset of phonation (Stemple, Glaze & Gerdeman, 2000). Individuals have been documented as experiencing success when using relaxation techniques as many patients with adductor spasmodic dysphonia adopt an extreme hyperfunctional posture in an attempt to "push" the voice through the spasms (Stemple, Glaze & Gerdeman, 2000).

The last participant was seen post-granuloma removal and presented with incomplete glottal closure when using normal phonation as well as when they employed the technique. Vocal cord granuloma may be unilateral or bilateral (Önerci, 2009). Intubation trauma, vocal abuse and gastroespohageal reflux have been found to be the main causative factors (Önerci, 2009). Anaesthetic tubes may cause trauma to the overlying mucosa of the vocal process of the arytenoid cartilage (Önerci, 2009). Prolonged vocal abuse may cause ulceration of the epithelium over the vocal process, known as a contact ulcer (Önerci, 2009). The etiology of the patient in the current study is likely to have been a combination of vocal abuse and gastroesophageal reflux. Glottal closure patterns of unilateral vocal fold lesions are associated with an incomplete glottal closure pattern (Murdoch, 1998). Steiner and Ambrosch (2000) report that incomplete glottal closure patterns are noted when large areas of tissue have been removed. The lack of change in closure pattern with the introduction of the technique is understandable as the Confidential voice technique has been reported to produce incomplete glottal closure (Casper & Colton, 2000).

Mucosal Wave

The second parameter that was noticeably affected when individuals with hyperfunctional voice disorders employed the Confidential Voice technique was the mucosal wave. Mucosal wave can be defined as the wave-like movement of the vocal fold epithelium as well as the superficial layer of the lamina propria during vibration (Bonilha, 2010). The vibrations of the vocal folds are passive phenomena and represent the basis for the aerodynamic theory of sound production (Sasaki, Kim & LeVay, 2010). The mucosal wave is produced by these vibrations (Sasaki, Kim & LeVay, 2010). The vibratory cycle is described as having three phases, namely, opening, closing and closed (Sasaki, Kim & LeVay, 2010). A cycle begins with the vocal folds closed, and it is during this phase that subglottic pressure increases, forcing the vocal folds apart inferiorly to superiorly until the glottis opens, letting air escape thereby reducing subglottic pressure (Sasaki, Kim & LeVay, 2010). The elastic recoil of the vocal folds forces the vocal folds back into an adducted position from an inferior to superior direction (Sasaki, Kim & LeVay, 2010). The vocal folds remain in the adducted position until the subglottic pressure builds up to the point that it forces the vocal folds apart (Sasaki, Kim & LeVay, 2010). From an anatomical perspective, the mucosal wave depends on the soft and compliant lamina propria and a healthy layered structure (Sasaki, Kim & LeVay, 2010). The mucosal wave can be affected by the presence of mass lesions, vocal fold scarring, sulcus vocalis, epithelial hyperplasia, mucosal drying, increased Fo as well as falsetto register phonation (Aronson & Bless, 2009). These conditions are all associated with a decrease in the mucosal wave excursion, while an increase in mucosal wave excursion is often associated with polypoid degeneration (Aronson & Bless, 2009). Regional variations in mucosal wave presentation may be as a result of focal tissue changes (Aronson & Bless, 2009). Nonvibrating segments are defined as regions of absence of mucosal wave and vibratory amplitude (Aronson & Bless, 2009). Based on the above it is not surprising that the mucosal wave was affected both when the participants of this study were using their “normal” phonation as well as when they employed confidential voice. The overall impact of the confidential voice technique on the voices of the participants was that there was a reduction in the excursion pattern of the mucosal wave. This is in keeping with what would be expected as the Confidential Vocie technique produces an incomplete glottal closure pattern which in turn reduces the subglottic pressure and thereby the point at which the vocal folds are set in vibration.

Amplitude

Amplitude is defined as the extent of lateral movement of each vocal fold during phonation (Bonilha, 2010). Vibratory amplitude is a measurement of the mediolateral distance the vocal fold moves between its maximum abduction and maximum adduction (Krausert, Ying, Zhang & Jiang, 2011). An increase in vocal fold mass is, for the most part, said to reduce the amplitude of vocal fold vibration (Gardner, 2010). Unilateral mass changes result in asymmetrical vibration (Gardner, 2010). Different mass lesions result in different effects on amplitude (Gardner, 2010).

The increase in mass of vocal folds is usually related to more extensive vocal pathology of the epithelium or the superficial lamina propria (Gardner, 2010). The larger the lesion the greater the resistive force in the displacement of the vocal folds and this is exaggerated if the lesion alters glottal closure, which is typical in mass lesions (Gardner, 2010). Stiffness of the vibrating portion of the vocal fold results in decreased vibratory amplitude (Gardner, 2010). This stiffness could be as a result of a host of pathologic factors such as scarring, infiltration of carcinoma, as well as submucosa benign mass lesions that are bound tightly to the epithelium and or the vocal ligament (Gardner, 2010). Therefore it is not surprising that the participants in the current study who had mass lesions, namely nodules, polyps and granuloma, had a reduction in the amplitude of the mucosal wave when using normal phonation. The introduction of the Confidential Voice technique was noted to reduce the amplitude of the mucosal wave even further. However the reduction as a result of the introduction of the technique can be attributed to the decreased subglottic pressure that is produced by a partially abducted glottis when producing the technique. As previously mentioned a reduction in subglottic pressure results in a reduction in the mucosal wave and its excursion pattern. Additionally, the increase in vocal fold tension can be attributed to muscle tension and not to any pathophysiological derangement of the vocal fold itself. Examples of this are spasmodic dysphonia or muscle tension dysphonia (Gardner, 2010). Adductor Spasmodic dysphonia is a neurological disorder that results in excessive and forceful closure of the vocal folds, and/or false vocal folds and/or the supraglottic constriction during phonation (Gardner, 2010; Aronson & Bless, 2009). The amplitude of vibration is significantly reduced or absent entirely and supraglottic activity is increased (Gardner, 2010). The excessive lateral compressive forces prevent the displacement of the vocal folds thereby dampening or eliminating vibratory amplitude (Gardner, 2010). The result of the current study is therefore different from the explanation provided Gardner (2010) as the amplitude of the mucosal wave was slightly affected when employing normal phonation and further reduced when employing the technique. The amplitude was however not absent or significantly reduced when using normal phonation, which may be due to the fact that the participant had had Botulinum toxin (Botox) treatment which would have reduced the hyperadduction of the vocal folds (Aronson & Bless, 2009). The reduction of amplitude when the participant employed the Confidential Voice technique is likely due to the incomplete glottal closure pattern associated with the technique. Incomplete glottal closure results in reduced subglottal pressure buildup, so that the displacement force of the vocal folds is reduced during phonation (Gardner, 2010). The reduction in the displacement of the vocal folds during phonation results in reduced amplitude of vibration during phonation (Gardner, 2010). By and large the amplitude of vibration relies on the interaction between the superficial lamina propria, the mass of the vocal fold, the length of the cord, the subglottic pressure, as well as the medial compressive forces created by muscular contraction (Gardner, 2010).

<u>Supraglottic Activity</u>

Supraglottic activity according to Bansel (2012) can be as a result of involuntary movements as in neurological conditions, such as spasmodic dysphonia, or compression or constriction. Compression can be consistent or intermittent (Bansal, 2012). Horizontal compression is either in the anteroposterior position or the lateromedial position (Bansal, 2012). Compression may be seen in normal voices and good singers have been documented as having anteroposterior compression. However greater anteroposterior movement has been seen in dysphonic voices (Bansel, 2012). Lateromedial movement is observed in instances of increasing pitch and in extreme instances, ventricular folds may touch and vibrate which may be the primary disorder or a secondary compensatory behaviour to other lesions such as incomplete glottic closure (Bansel, 2012). Compression that is sustained during phonation is often noted in functional voice disorders (Bansel, 2012). Supraglottic activity is defined as excessive ventricular fold movement or assistance during phonation (Jacobson, 1994). When commenting on the supraglottic activitiy it is important to comment on the anterior to posterior press as this is indicative of hyperfunctional activity (Jacobson, 1994). The overacrching result of the current study in terms of supraglottic activity is that it was reduced when employing the Confidential Voice technique across all participants with documented presence in their normal phonation. In the current study, supraglottic activity was noted in participants who had unilateral vocal nodules; vocal cord hemorrhage; post-operative nodules and adductor spasmodic dysphonia. These individuals presented with a reduction in supraglottic activity when employing the Confidential Voice technique. The results of this study are in keeping with existing evidence as individuals with adductor spasmodic dysphonia have been found to present with supraglottic activity in severe cases (Aronson & Bless, 2009). Secondly, the presence of supraglottic activity in the participants with vocal nodules is a result that has been previously documented and therefore not unexpected (Mathieson, 2001) as vocal nodules are functional voice pathologies. Finally, the presence of supraglottic activity in the participant who had a hemorrhage could be attributed to the fact that the participant was a singer and presented with a functional voice disorder. Therefore the result is not unexpected as these findings were documented by Bansel (2012). Supraglottic activity was reduced in these participants when employing the technique. This could be attributed to a more incomplete glottal closure pattern which allows for easier voice onset due to reduced muscle tension and increased airflow as hypothesised by Colton & Casper (2000) and shown through the current study's results.

Phase Closure

Phase closure refers to the relative duration of the open and closed phase of the vibratory cycle (Poburka, 1999). At normal pitch and loudness the open phase could account for approximately 40 to 60% of the vibratory cycle (Aronson & Bless, 2009). A vibratory cycle that is predominately open phase is associated with breathy vocal quality due to hypofunction (Aronson & Bless, 2009). This parameter was affected with the introduction of the Confidential Voice technique and was an expected result as the aim of the technique was to produce incomplete glottal closure to reduce hyperfunctional behaviours. Despite the varied presentation of vocal pathology, participants presented for the most part with increased open phase when employing the technique.

Nonsignificant parameters

In the current study the parameters of non-vibrating portions; vocal fold straightness; vocal fold smoothness; vertical level; phase closure or regularity were not affected by the technique.

Non-vibrating portions of the vocal folds were unaffected by the technique. A non-vibrating portion refers to the stiffness of each vocal fold and has implications for the degree of infiltration of a lesion on a vocal fold (Jacobson, 1994). It also serves as an indicator of degree of scarring post phonosurgery (Jacobson, 1994). Confidential voice technique has five aims, namely, to eradicate hyperfunctional and traumatic vocal behaviours; secondly, to allow for lesions to heal in the absence of continued vocally traumatic phonation; thirdly, to reduce vocal fatigue and excessive muscle tension; fourthly, to reduce the internal vocal meter; and lastly to promote a heightened awareness of voice use and speaking environment (Casper & Colton, 2000). It is not the voice therapy technique of choice in the treatment of scarring or eleviating stiffness. Therefore this result was not unexpected.

The second and third parameters that were unaffected were vocal fold smoothness and straightness. These parameters refer to the medial edge of the vocal fold for smoothness and straightness (Colton, Casper & Leonard, 2006; Poburka, 1999). Intracordal cysts and polyps would affect the vocal fold straightness but not vocal fold smoothness (Poburka, 1999). Smoothness would be affected by vocal nodules or polyps (Angell, 2009). These parameters would not be affected by the technique directly, although the technique is used to treat mass lesions that occur on the medial edge of the vocal fold. The technique aims to reduce the contact of the vocal folds and in so doing allows the vocal folds to heal (Casper & Colton, 2000). The technique does not have an immediate effect on these parameters. However if the technique is employed for the prescribed period it has been documented to reduce the size of the mass lesions. Therefore the technique has an indirect effect on these parameters which is not noticeable immediately.

The final parameter that can be evaluated using the SERF developed by Poburka (1999) is regularity. Regularity can be defined as the degree to which one phonatory cycle is like the following cycle (Poburka, 1999). This parameter can be evaluated using the stop phase or the running phase (Poburka, 1999). This measure is determined by the user on the stroboscopy unit (Poburka, 1999). This parameter was therefore excluded and not analysed.

Patient Perceptions

The fundamental goal of any medical therapy is to achieve certain outcomes in the patients we treat (Jin *et al.*, 2008). However, outcomes might not be achievable despite the best intention and efforts of the healthcare professionals, if the patients are non-compliant (Jin *et al.*, 2008). Sadly non-compliance has plagued therapists and it is for this reason that therapeutic compliance has been a topic of clinical concern since the 1970s (Jin *et al.,* 2008). Therapeutic compliance is not limited to compliance with medication but includes compliance to other recommendations such as diet, exercise, or life style changes (Jin *et al.*, 2008). In order for patients to be compliant they need to see the benefit in performing the instructions requested of them by the therapist. Furthermore they need to understand fully what is required of them. It is for these reasons that the current study aimed to find out how patients with hyperfunctional voice disorders perceived the Confidential Voice technique. The researcher devised a five- question questionnaire, which each participant completed after being taught the Confidential Voice technique. The results were analyzed using descriptive analysis.

The first question enquired about the participants' understanding of the Confidential Voice technique. The majority of the participants demonstrated a good understanding of the technique and were able to explain the technique to the researcher accurately. There was however, a misconception that it was a speaking voice "so other people can't hear". The technique was explained as "a speaking voice that is softer and more breathy than an individual's normal speaking voice". The example used to illustrate it was "the speaking voice one would use when communicating something private to someone that you don't want others to overhear". This is still audible to a close listener but not to communication partners that are further away. This is in keeping with the objective results as they revealed that the voice is reduced in intensity and in pitch. Moreover, it is a breathy voice as it is produced with a partially opened glottis. A recommendation for future research could be to adjust the manner in which the technique is explained to patients and determine if this alters the patients understanding.

The second question asked was how the participant felt their voice changed when they employed the technique. The majority of participants described their voices as "lower/softer/quieter" and "less strained". This is encouraging as the technique was designed to reduce strain on the vocal folds, moreover the voice is expected to be softer given the physiology of the technique which has been confirmed through the current study. However, "strain" is usually a perceptual characteristic of adductor spasmodic dysphonia, and the current study has shown that the technique increased hyperfunction in the laryngeal musculature of the participant with adductor spasmodic dysphonia.

The third question was whether they thought they could employ the technique in their everyday communication for the prescribed time period and to substantiate their answer. Half the participants felt they could use the technique in their everyday lives while the other half felt they could not as it would limit them. One participant stated "It's against my natural personality" and therefore reported that she would not use the technique. The majority of the participants were professional voice users. The term professional voice user refers to all people who use their voices as a predominant part of earning their livelihood (Thurman & Klitzke, 1994). This population is comprised of singers, actors, ministers, teachers and lecturers, salespersons, attorneys, telephone operators, radio and television personalities, school class leaders and public officials and are referred to as professional voice users (Thurman & Klitzke, 1994). These individuals are more likely to adhere to the advice of a professional, as they are aware that their livelihoods depend on their voices being in optimal condition (Teixeira *et al.*, 2013).

The fourth question asked was what the participants perceived as the benefits and limitations of the technique. From the above it is evident that the participants perceived benefit from the technique in the form of "less strain/force" but found it limiting socially and that it required a level of concentration. One participant stated, "I found it very difficult especially socially, I felt isolated and often withdrew from social encounters.". This was an eye-opener to the researcher as voice therapy, like all therapies, is aimed at restoring function, in this case the best voice possible that will allow for employment and general communication (Colton, Casper & Leonard, 2006). Furthermore, the International Classification of Function, Disability and Health (ICF) is a framework for functional health which can be used as an effective clinical tool, as it allows us as clinicians to view our patients wholistically and determine the best course of treatment for them. Threats (year unknown) stated that our responsibility as professionals includes trying to effect change socially and politically to help our clients cope in the world. Therefore in light of this statement if a therapeutic technique makes a patient feel more isolated and less able to cope then it is not the best-fit approach for that particular patient. Teixeira (2013) states that recommendations to change a behavior may have a significant impact on the effectiveness of voice therapy, as the result is more determined by adherence to treatment recommendations, rather than the method applied.

The fifth and final question was about the participants' understanding of why the technique was prescribed for their voice problem. For the most part the participants understood why the technique was recommended for their voice problem. Interestingly, participants showed a good understanding of why the technique would be prescribed for them, however some still felt that they would not be able to adhere to the technique in their everyday lives. One participant stated, "Supposedly it should help the healing BUT practically in my everyday life I cant see myself 'behaving'. Yelling at dogs and kids? Its not possible… I'm not heard or listened to easily – I need to make more effort." This statement reinforces the findings of Teixeira (2013) in that individuals who are required to make behavioural changes may not adhere to the advice given by the treating clinician and in so doing may not have as successful treatment outcome as predicted.

CONCLUSIONS

Existing Knowledge and Additional Knowlege

The Confidential Voice technique was introduced by Colton and Casper in 1990 and has since been a technique that is commonly used by voice therapists across the globe. Verdolini-Marston *et al.* (1995) stated that confidential voice therapy is considered predominantly effective in the early stages of treatment for maximum early reduction of lesions and of dysphonia. Moreover, Confidential voice is an approach that is used in the treatment of benign lesions, muscle tension dysphonia, hyperfunctional dysphonia, vocal fatigue and in early postoperative periods (Casper & Colton, 2000). It has been used to reduce vocal fold contact and in so doing, on a physiological level, it was hypothesised to be associated with reduced vocal fold collision and reducing muscle tensions and hyperfunctional behaviour (Colton & Casper, 2000). The quality of the voice produced is breathy as it is produced with slightly abducted vocal folds (Colton & Casper, 2000). Colton and Casper (2000) further hypothesised that this abduction would result in increased airflow and thereby reduced loudness. They based their physiological theory on Jiang and Titze's (1994) study that demonstrated that intraglottal contact appeared to increase as vocal fold adduction increased. Therefore Colton and Casper (2000) hypothesised that the inverse should hold true, that is that reduced intraglottal contact would cause reduced collision force. Based on the above, Colton and Casper (2000) hypothesised that decreased irritation caused by forceful intraglottal contact, as seen in hyperfunctional voice disorders, should support healing. Colton and Casper (2000) stated that if the technique is applied appropriately then supraglottal constriction and excessive muscle tension are also reduced. Reduced vocal intensity that is associated with this technique is deemed an immediate benefit of this technique but according to Colton and Casper (2000) it is the element that is often deemed the drawback of the approach by other sceptics.

The current study evaluated the Confidential Voice technique on an acoustic, aerodynamic and visual level as well as patient perceptions of the technique. The current study included evaluations of patients with vocal nodules, post-operative patients, polyps, vocal cord hemorrhage, intracordal cysts and spasmodic dysphonia. The sample size was small, however it is felt that the results of the current study provides valuable information regarding these pathologies and could serve as a springboard for further research and the applicability of the technique for each of the pathologies mentioned in the current study. The small sample size may have affected parameters in that they may be more significantly affected in a larger sample.

In terms of the knowledge gained from the current study from the stroboscopic examination. The current study found that the technique yields a more open glottal closure pattern, decreased mucosal wave and amplitude. Furthermore it was found to decrease the supraglottic activity and lead to a increase in the open phase of phonation. It was found not to impact on non-vibrating portions; vocal fold straightness; vocal fold smoothness; vertical level; phase symmetry or regularity. These results are in keeping with what the authors of the technique hypothesised and what was found in other research studies using the technique.

The more open glottal closure pattern was initially hypothesised to significantly affect aerodynamic measures such as expiratory cycle. However the current study did not show a significant difference between the expiratory cycle of normal phonation verses breathy phonation and therefore brings into question how significant the change in glottal closure is when employing the technique. Level of significance was not established in the current study as the measure used to assess the stroboscopic evaluations was analysed descriptively rather than statstically. Therefore it is recommended that further research be done into whether or not the change in glottal closure is significantly different between normal phonation and breathy phonation.

Secondly, the changes in mucosal wave and amplitude were expected given the reduced vocal fold contact and increased airflow through the glottis. Moreover, the decrease in supraglottal activity and increase in open phase of phonation when employing the technique was also expected given the incomplete glottal closure which allows for easier voice onset due to reduced muscle tension and increased airflow as hypothesised by the technique's authors and shown in the current study. However, when examining the other acoustic and aerodynamic measures that evaluate tension it would appear that the results are not in agreement. One participant presented with adductor spasmodic dysphonia, a muscle tension disorder, and therefore is a good example of whether or not the technique does in fact lower tension as it was hypothesised to by the authors. The results showed that for the number and degree of voice breaks which are associated with muscle tension disorders such as adductor spasmodic dysphonia, the use of the Confidential Voice technique increased voice breaks which was an unexpected result. Moreover, nine out of the twelve participants showed an increase in degree and number of voice breaks when employing the technique. The other acoustic measures affected by tension of the vocal folds, i.e. fundamental frequency and RAP, the results were in keeping with what the authors and other researchers have found. The fundamental frequency was reduced when employing the technique which was expected and the RAP values were elevated as RAP is a perturbation measure which is affected by vocal pathology. The other aerodynamic measure affected by tension is the pitch period and was also found to be in keeping with results by other researchers such as Smolover and Bertoli (2006). Furthermore other studies have documented the increased open phase when using breathy phonation. In terms of the elevation in voice breaks when employing the technique, it is recommended that further research be done to determine why there is an increase in voice breaks rather than a decrease when utilising the technique. Moreover, further research into why tension appeared to increase in individuals with adductor spasmodic dysphonia in a larger sample is recommended.

Moreover, the Soft Phonatation Index which has been found to be affected by breathy phonation in other studies was found not to be significantly affected in the current study. However the means were affected when utilising the technique which is in keeping with the findings of other researchers. SPI is an evaluation of the weakness of the high frequency harmonic components which is an indication of loosely adducted vocal folds during phonation (Mathew & Baht, 2009). Therefore the non-significance of this parameter is likely due to the small sample size and may prove to be significant in larger samples. However, interestingly, the individual with adductor spasmodic dysphonia was noted to have a decline in SPI, which is indicative of tighter vocal fold adduction. Therefore in this individual the technique appeared to have the opposite effect and once again reitterates the need for further research into this population and the utilisation of the technique.

Additionally, the voice turbulence index should have been affected as it is a measure that correlates with the turbulence caused by incomplete vocal fold adduction. However, the current study did not yield a significant result for this parameter. The means were elevated when employing the technique but not significantly so and therefore the sample size may have affected this result. Therefore further research with a larger sample size may yield a more significant result. Interestingly, individuals who showed an increase in the VTI measure had a variety of voice pathologies, namely, nodules, polyps and post-operative granuloma. Moreover, the individual who presented with adductor spasmodic dysphonia had the opposite result when utilising the technique and therefore further contributes to the evidence that perhaps this technique is not appropriate for this population.

The final acoustic parameter which should have been affected by the technique but was not significantly affected was the noise-to-harmonic ratio. This is a measure of the amount of noise in a signal as compared to the signal. The higher the noise the poorer the voice quality, and noise is often a result of air passing through the glottis. Based on this it can be seen that this parameter should have been affected since the technique yields an incomplete glottal closure pattern yielding easier escape of air through the glottis. Moreover, NHR is a measure of hoarseness and all the participants within the current study had vocal pathologies which has hoarseness as a component of their presentation. The fact that NHR was not significantly affected is likely due to the small sample size as the means were affected but not significantly so. Therefore a larger sample may result in more significant results.

In terms of aerodynamic measures used to evaluate the Confidential Voice technique, the following parameters were found to be affected, Maximum SPL, Maximum Pitch, Pitch Range, Phonation Time and Peak Inspiratory Airflow. Since the glottis is more open when producing the technique it should yield greater/faster escape of air during phonation, yielding shorter utterances. However, interestingly, there is no significant difference between speech with and without confidential voice. However, the voices of the participants in the current study were found to be lower in pitch and intensity when employing the technique as predicted by the authors. Secondly, the pitch range as previously mentioned, was affected by the introduction of the technique which is to be expected as the technique shortens the vocal folds, resulting in less tension and therefore slower vibration. Thirdly,the phonation time was reduced when employing the technique which is expected as the technique was hypothesised to utilise more air given the incomplete glottal closure, therefore it is not surprising that the peak inspiratory airflow measure was affected.

At a physiological level, the reduction of hyperfunctional vocal behaviours is the fundamental benefit of this technique. This is deemed beneficial as the patient is required to change habitual patterns of voicing, to develop a heightened awareness of ambient noise levels and learn to make appropriate adjustments (Colton & Casper, 2000). The downfall of this technique is the difficulty in being heard above the ambient noise or in speaking situations that require louder phonation (Colton & Casper, 2000). It is in these situations that the individual needs to become imaginative in adjusting to the new speaking demands (Colton & Casper, 2000). The current study echoed these findings as the participants felt that the technique was limiting in social settings and requires a significant amount of concentration in order to utilise it effectively. Half of the participants felt that they could employ the technique for the prescribed period, which is on average approximately two to four weeks; while the other half of the participants reported not being able to employ the technique. These results are in keeping with other research such as Teixeria (2013) who stated that recommendations to change a behavior may have a significant impact on the effectiveness of voice therapy, as the result is more determined by adherence to treatment recommendations, rather than the method applied.

According to Colton and Capser (2000), the confidential voice technique has five fundamental uses. Firstly, it is used to eradicate hyperfunctional and traumatic vocal behaviours; secondly, its use allows for lesions to heal in the absence of continued vocally traumatic phonation; thirdly, it is thought to reduce vocal fatigue and excessive muscle tension; fourthly, it serves to reduce the internal vocal meter; and lastly it promotes a heightened awareness of voice use and speaking environment (Colton & Casper, 2000). At the very core of the technique its holistic aim is to create healthier vocal folds and an objective position which promotes healthy voice use which can be taught and expanded upon through the use of a variety of techniques (Colton & Casper, 2000).

The current study found that the Confidential Voice did reduce hyperfunctional behaviours for individuals with vocal nodules and vocal hemorrhage, however it appeared to have the opposite effect on the participant with adductor spasmodic dysphonia, as previously discussed. As afore mentioned, Colton and Casper (2000) stated that if the technique is applied appropriately then supraglottal constriction and excessive muscle tension are also reduced. Therefore further research into the effects of the technique on adductor spasmodic dysphonia may prove useful to assist therapists in deciding whether the Confidential Voice technique is indeed contraindicated. Moreover, participants with vocal polyps and intracordal cysts did not appear to benefit from the technique directly other than it has been hypothesised that it would reduce any further vocal fold pathology as a result of vocal abuse. Vocal polyps have been found to be as a result of vocal abuse (Corbridge, Thirlwall, Patel & Martinez-Devesa, 2009), however the cause of intracordal cysts is largely unknown, however vocal trauma has been considered a contributing factor (Colton, Casper & Leonard, 2006). Therefore, it seems logical that the technique can be used in these pathologies in order to ensure that further vocal pathology does not occur. According to Corbridge, Thirlwall, Patel and

Martinez-Devesa (2009) intracordal cysts do not benefit from voice therapy and individuals who have vocal polyps only benefit from therapy post-operatively. However, post-operative application of the technique does seem to be beneficial as it allows for the vocal folds to heal in the absence of vocally traumatic phonation. Three participants in the current study were seen post-operatively and the results showed a decrease in vocal fold contact and vocal fold vibration. This is said to aid vocal fold healing as Confidential Voice technique has been recommended as a wound healing technique in place of voice rest (Aronson & Bless, 2009).

Previous research has investigated the efficacy of Confidential Voice in comparison to other treatments such as resonant voice therapy. Of the two studies found in an extensive search of the literature, Verdolini-Marston *et al.* (1995) investigated the efficacy of Confidential Voice therapy and Resonant Voice therapy, in the treatment of laryngeal nodules. The participants were evaluated over a 12 day period by means of phonatory effort ratings, auditory-perceptual ratings of voice and visual-perceptual ratings of the larynx (Verdolini-Marston *et al.*, 1995). Results showed that some benefit could be noted between participants and those in the control group (Verdolini-Marston *et al.*, 1995). On all measures 60% (three out of five) of participants across all measures showed improvement over the two week period as compared to the control group (Verdolini-Marston *et al.*, 1995). However, there was little evidence as to the superiority of one of these techniques (Verdolini-Marston *et al.*, 1995). Interestingly both types of therapy had a similar likelihood of improving participants' voices, provided they had generalised the technique to their everyday lives (Verdolini-Marston *et al.*, 1995).

The second study found, evaluated three treatment techniques commonly used in the treatment of hyperfunctional voice disorders namely confidential voice therapy, resonant voice therapy and the accent method. Three patients were treated using confidential voice, four using resonant voice therapy and three used the accent method (Leddy *et al.*, 1997). Leddy *et al. (*1997) measured the patients' outcomes using a client rating questionnaire and the Functional Communication Measure of Voice Disorders (FCMVD). This study reported benefit from all three techniques. Leddy *et al.* (1997) reported that confidential voice is particularly effective in the treatment of nodules or laryngitis. They emphasised that it is not a technique that should be used indefinitely but rather this technique allows patients to have a voice they can use while their vocal tissue heals (Leddy *et al.*, 1997).

Therefore in summary, in terms of the current knowledge base for confidential voice technique we know that on a physiological level it has the desired effect in that if produced correctly it yields incomplete glottic closure and also in addition we know that participants and therapists alike perceive an acoustic benefit as a result of this approach. The authors (Colton & Casper, 1996; Casper, 2000) of the technique have reported, as previously mentioned, that the technique is not effective for all patients with hyperfunctional voice disorders however the authors failed to explain why this is so. The current study reitterated these findings, however further included information on the reasons behind how the technique works on a physiological, acoustic and aerodynamic level. The current study found that an individual with adductor spasmodic dysphonia did not benefit from the technique and therefore further research with a larger population is indicated. The current study also provided insight into possible reasons why the technique may be unsuccessful from the patients' perspective and confirmed that in order for therapy to be successful there needs to be buy in from the patient. Furthermore, therapy should always take into account the possible psychosocial effects of the recommendations and ensure that therapy does not result in further disability. The current study showed that for some participants this technique left them feeling isolated and not empowered. This study showed that patients may have a good understanding of the technique and some may be willing to buy into the therapy technique as a short-term option, however the participants in the current study highlighted that the technique has its limitations. The majority of the participants in the current study were professional voice users and since hyperfunctonal voice disorders have a high incidence in the professional voice user population due to their vocal demands it is not surprising that these individuals find it a challenge to employ the technique. Professional voice users tend to be extroverted individuals and as some participants mentioned the technique is not one that fits in with their personalities and often leaves them feeling isolated in social settings. However professional voice users are often willing to do what the professional recommends despite how it may make them feel as their voice is at the end of the day their bread and butter. But is the Confidential Voice technique the best therapeutic technique for our patients or are there others that will yield the same result without making the patient feel isolated and require a signficant amount of concentration when communicating? From the perspective of the researcher it is felt that perhaps the technique is best used in conjunction with other therapy techniques. Moreover, it is best used post-operatively and then the voice therapist should transition to patient into another technique such as resonant voice. Moreover, the vocal pathology that the patient presents with should be considered when determining the most appropriate technique to transition the patient into using after a period of Confidential Voice use.

Limitations and Areas for Further Research

The existing studies on the Confidential Voice technique, including the current study, have been done on small populations. This is deemed a constraint and therefore the results that were found to be non-significant may have been significant if the sample size was larger. Moreover, the interesting results for the participant with adductor spasmodic dysphonia should be further investigated in a larger sample size to determine whether or not the Confidential Voice technique should not be used at any stage of treatment for this population. Moreover, the current study evaluated the immediate effect of the technique on an individual's voice, and therefore did not appear to be beneficial for individuals with vocal polyps or intracordal cysts, however as previous research suggests individuals with these types of vocal pathology may benefit from the technique post-operatively. Therefore further research into the applicability of the technique in the long term, or post-operatively, may prove beneficial. Moreover, the current study did prove that the technique is beneficial in the treatment of vocal nodules and vocal fold hemorrhage and is in keeping with other studies, however there was an increase in the number and degree of voice breaks when utilizing the technique and therefore further research into why the technique increased voice breaks could further add to the knowledge base for the applicability of this technique in the treatment of hyperfunctional voice disorders. Moreover, the level of significance for acoustic parameters such as VTI, NHR and SPI to further support the effect of this technique is indicated as the current study showed a change but was unable to establish significance.

In conclusion it is felt that the current study achieved what it set out to achieve in that it provides useful information regarding how the Confidential Voice technique works on an acoustic, aerodynamic and visual level in individuals with hyperfunctional voice disorders. Additionally, the current study provided some insight into patients' level of understanding of the technique as well as their perceptions on the technique and whether or not they felt they could employ it. Moreover, the current research has highlighted areas that require further research in terms of the techniques applicability for certain vocal pathologies. Therefore knowing the pathology and having a repetoire of techniques available for trestment is only the beginning of what is required for a technique to be successful. Aronson and Bless (2009) said it best, "Voice therapy revolves around physiologic principles designed to restore normal biomechanics to the vocal apparatus. In an attempt to restore voice, underlying pathology may be revealed as voice problems are often multifactorial. Restoration of the mechanical properties are only part of the treatment. Therapy is also tailored to the voice and personality of the patient and pays attention to emotional as well as the mechanical and acoustic aspects of abnormal voice." (Aronson & Bless, 2009, p. 265).

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Appendix A: Participant Information Form

SPEECH PATHOLOGY AND AUDIOLOGY

School of Human & Community Development

Faculty of Humanities

University of the Witwatersrand

PARTICIPANT INFORMATION FORM AND INFORMED CONSENT FORM

Hello, my name is Bianca Serrão and I'm a Masters student at the University of the Witwatersrand in Speech Therapy and Audiology. I am currently conducting research in the area of voice therapy. The title of my study is "Confidential Voice – The Secret Revealed".

Confidential Voice is a technique used in the treatment of voice disorders such as vocal nodules, polyps, cysts, Reinke's oedema, chronic laryngitis, vocal ulcers and adductor spasmodic dysphonia. The technique requires you to use the softest voice you can produce, as in the voice you would use to relay confidential information to another person so that others cannot hear. This study will evaluate how this technique changes your voice. You will also be required to complete a questionnaire on your experiences in using the technique. The findings have implications for the management and care of the voice as well as preventative strategies for voice misuse and damage.

The study will take place at the Speech and Hearing Clinic, University of the Witwatersrand and I would like to invite you to participate.
If you decide to participate in this study, I will request approximately one hour of your time spread over two sessions where the following procedures will take place:

1. I will provide you with a questionnaire pertaining to your experience employing the confidential voice technique that I will require you to complete. This will take approximately 5 – 10 minutes of your time.
2. A qualified and highly skilled voice therapist will perform aerodynamic and acoustic analysis measures. Aerodynamic measures and acoustic analysis of vocal function are methods used in clinical and research settings. You will be required to read a passage into a microphone that is connected to a computer with speech analysis software. By examining the sound signals radiating from the mouth, considerable information can be inferred regarding the underlying laryngeal physiology and functioning.

These measures are fairly brief and are likely to take a maximum of five to ten minutes per person.

3. You will be taught the confidential voice technique by the voice therapist and then be required to reread the passage using the technique. Your voice will be recorded and analysed acoustically and in terms of air flow. This is also likely to take you a maximum of ten minutes to complete.

Please be aware that your participation would be completely voluntary and you are welcome to leave the study at any time without any negative consequences to you. If you decide to be a participant, you will be required to notify my research supervisor, Prof. Heila Jordaan (082 323 8016 or heila.jordaan@wits.ac.za), by sms or email as to whether or not you will be participating in the study. You will not have any contact with me regarding your participation in this study. Additionally, you will be required to sign a form stating that you understand the methods and purpose of this study. You will have your own copy of the form.
Please be aware that you will not receive any financial compensation from the researcher should you agree to participate.

What are your rights?

1. You have the right to withdraw from the study at any time, with immediate effect with no negative consequences to you or your right to further treatment.
2. You have the right to see the results of the study.
3. You have the right to contact me at any time with any queries or concerns.
4. If you have any concerns or complaints about the study or me as the researcher, you have the right to contact the Human Research Ethics Committee (Medical) chairperson, Professor Cleaton-Jones or the Research Administrator, Ms. Anisa Keshav on 011 717 1234.

Anonymity

Your participation will be kept completely anonymous. Your name and personal information will not be revealed in any form. Your name will be replaced with a code.

If you decide to participate in this study, please sign the consent form attached.
Thank you for your time. If you would like to know the results of the study, a report will be made available to you upon completion of my study.

Please do not hesitate to contact me if you require further information.

Kind regards,
Bianca Serrão
083 973 6279 or bianca.research@gmail.com

Appendix B: Informed Consent

INFORMED CONSENT:

In terms of the research study entitled "Confidential voice – the secret revealed"

I, ____ (name of participant), the undersigned, agree to volunteer in this study in writing. I have been informed about all areas of the study. I am aware of the fact that the onus lies with me to arrange transport to and from the voice clinic once the examination is complete. All my questions have been answered, and I know that I can withdraw from the study at any time without any negative consequences. I am also aware that confidentiality will be maintained throughout the study.

________________________________ Date: _______________

Participant

I, the researcher, confirm that the participant is aware of all aspects related to this study, including the procedures and benefits of this study.

______________________________ Date: ______________

Witness

______________________________ Date: ______________

Witness

Appendix C: Case History Form

Case History Form

THE VOICE AND SWALLOWING CLINIC

Dr. Lance Maron FCS. (SA)
Dr. Heila Jordaan MA (Speech Pathology) PhD.

Appointments: (011) 6438047 **Fax:** (011) 6438065 **Address:** Parklane Clinic, Parktown

PATIENT'S NAME: ______________________________

FAX NO/ EMAIL ADDRESS: ______________________________

In an attempt to provide high quality care for our patients and in line with international trends, we adopt a multi disciplinary approach to voice and swallowing disorders using state of the art equipment operated by specialized staff. Below we provide some information that will answer any questions you may have. Please do not hesitate to contact us beforehand should you require any further information.

IN PREPARATION:

Kindly complete the detailed questionnaire pertaining to your problem either when it is faxed/emailed to you, or if this is not possible, arrive 15 minutes before your scheduled appointment to complete the form. This will enable us to evaluate your problem as comprehensively as possible. Also, please read and complete the attached consent form for the use of your clinical information for research purposes.

WHO WILL I SEE?

You will see a team comprised of an ear nose and throat surgeon who specializes in voice problems, a speech therapist and a vocal coach (if you are a performer). Medical and speech therapy students may also attend the clinic as it serves as a teaching facility. You should therefore expect a number of people to be present at your consultation. Should you have any difficulties with this please let us know beforehand.

WHAT WILL HAPPEN AT THE CONSULTATION?
After a discussion of your problem and history, you will be examined. This includes an ear nose and throat examination and video stroboscopy - an advanced technique for viewing the throat and vocal chords using a camera. This will be followed by a discussion on the diagnosis and recommendations for treatment. Where appropriate, you will be advised to attend a follow-up session with the voice therapist and performers may also be referred to the vocal coach for an extensive evaluation and advice. Follow-up appointments are usually recommended to asses your response to treatment and may occur within two to six weeks of the first consultation.

WHAT ARE THE COSTS AND HOW DO I PAY?
Kindly note that the voice and swallowing center is a cash practice. Payment is required on consultation and can be made via cash or card. The consultation and procedures are charged at ***medical aid rates*** and the cost is approximately R 2 250, 00 (this may vary

depending on what procedures are necessary). It is recommended that you get pre-authorization from your medical aid prior to your appointment. They will require the following info:

Practice no: 0086207

Procedure codes: 0191/ 2; 1118; 1018; 1019; 5930; 3284; 3285.
ICD-10 code: R49.0

We look forward to seeing you and assure you of our best attention at all times.

CONSENT FOR THE USE OF CLINICAL INFORMATION

This document must be explained to the patient by a member of the clinical staff

You are presently a patient or are scheduled to be seen for problems you are currently experiencing at the Wits University Donald Gordon Voice and Swallowing Centre. The centre not only renders treatment but is also actively involved in conducting research aimed at improving the quality of the care we deliver. From time to time such research involves the use of patient records from which information is extracted. The use of such information is subject to:

- **Approval from the Committee for Research on Human Subjects (University of the Witwatersrand).**
- **Anonymity: in other words the identity of the patient from whose file information is extracted is never revealed to anyone but the researcher unless specific consent is obtained from the patient to do so.**

We would like to obtain your consent to use information from your / the patient's file for the purpose of our research, subject to the above mentioned conditions.

If you choose not to give your consent, then so doing will not compromise your or the patient's current or future treatment in any way. If at any time in the future, you choose to withdraw this consent, you are free to do so and this again will not prejudice your or the patient's current or future treatment in any way.

Should you wish to contact us at any stage regarding this consent, please contact the voice and swallowing centre on 482 5524

________________________________ ______________________

Print patient's full name and surname VSC File Number (for office use)

DELETE WHICHEVER IS NOT APPLICABLE:

YES	I, the undersigned, hereby give consent for my / the patient's records to be used as per the above mentioned conditions for the purpose of research

NO	I do not give consent for the use of my / the patient's records for the purpose of research

Full name of person **giving/declining** consent Write "SELF" or give relationship to patient

Signed at ______________________ on __________________________________

_______________________________ _________________________________

Patient Person Giving Consent

Witness #1: ____________________________ Signature: ____________________

Witness #2: ____________________________ Signature: ____________________

PATIENT NAME: ________________________ **DATE:** ________________________

REFERRING PHYSICIAN & CONTACT NO: ____________________________

HISTORY OF MAIN COMPLAINT
What is the main problem/s?

- ☐ Voice problem
- ☐ Swallowing problem
- ☐ Breathing difficulties

When did the problem start? ____

Did anything trigger the problem? If yes, what? ____________________________________

Have you had any treatment for this condition – meds, voice rest, speech therapy, surgery? ______ ____

Did anything help?
____
____

ENT HISTORY
Do you suffer any of the following problems?

☐ Hearing difficulty ☐ Blocked nose ☐ Frequent sore throats

☐ Ear pain ☐ Hay fever ☐ Tonsillitis

☐ Ear infection/ discharge ☐ Sinusitis ☐ Pain/stiffness in the neck

☐ Dizziness ☐ Nose bleeds ☐ Lumps in the neck

☐ Tinnitus/ ringing in the ears ☐ Postnasal drip ☐ Head or neck injury

____
____

MEDICAL HISTORY
Do you or have you suffered any of the following problems?

☐ Weakness/fatigue ☐ Tuberculosis ☐ Depression/ Anxiety

☐ Weight loss ☐ Heartburn/ Acid reflux ☐ Diabetes

☐ Loss of appetite ☐ Nausea/ Vomiting ☐ Thyroid disease

- Visual disturbance
- Diarrhea
- Kidney problems
- Heart trouble
- Headaches
- Arthritis
- Palpitations
- Numbness in face/legs/arms
- Joint pains or stiffness
- High blood pressure
- Epilepsy
- Skin rashes
- Shortness of breath
- Blackouts
- Bleeding or bruising
- Cough
- Memory loss
- Anaemia
- Asthma
- Sleep problems
- Cancer

____
____

Have you ever had a breathing tube in place (been intubated or ventilated)?
____

SURGICAL HISTORY
List year and types of operations you have had:

Year Operations

_____ ____

_____ ____

_____ ____

MEDICATION
List any medication you are on (including vitamins, oral contraceptives, over the counter medications or alternative/ homeopathic treatments):

_______________ _______________ _________________

_______________ _______________ _________________

_______________ _______________ _________________

ALLERGIES
Do you have any of the following?

Medical allergies ____

Food allergies ____

Environmental allergies ____

Have you ever been tested for allergies? (give details) ______________________

SOCIAL HISTORY
What is your occupation? ____

Marital status: ☐ single ☐ married ☐ widowed ☐ divorced

Children (ages) ____

Do you smoke? If so, how many per day? ____________________________________

Do you drink alcohol? (Please provide detail) _________________________________

How much coffee, tea or coke do you drink daily ______________________________

What forms of exercise do you do? ____

FAMILY HISTORY
Does/did any blood relative have any of the following? Please indicate which relative.

☐ Heart Disease ☐ Stroke ☐ Voice Problems

☐ Diabetes ☐ Thyroid disease ☐ Epilepsy

☐ Hearing loss ☐ Mental illness ☐ Bleeding Disorders

☐ Migraine ☐ Dizziness ☐ Cancer

GYNAECOLOGICAL HISTORY (for females only)

When was your last period? ____

Are your menstrual periods regular? ____
Are you pregnant? ____

Have you undergone hysterectomy and were your ovaries removed? ________________

Have you gone through menopause? ____

VHI

These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

0=Never 1=Almost Never 2=Sometimes 3=Almost always 4=Always

Part I-F					
1. My voice makes it difficult for people to hear me.	0	1	2	3	4
2. People have difficulty understanding me in a noisy room.	0	1	2	3	4
3. My family has difficulty hearing me call through the house.	0	1	2	3	4
4. I use the phone less often than I would like to.	0	1	2	3	4
5. I tend to avoid groups of people because of my voice.	0	1	2	3	4
6. I speak with friends or relatives less because of my voice.	0	1	2	3	4
7. People ask me to repeat myself when speaking face-to-face.	0	1	2	3	4
8. My voice difficulties restrict personal and social life.	0	1	2	3	4
9. I feel left out of conversations because of my voice.	0	1	2	3	4
10. My voice problem causes me to lose income.	0	1	2	3	4
Part II-P					
1. I run out of air when I talk.	0	1	2	3	4
2. The sound of my voice varies throughout the day.	0	1	2	3	4
3. People ask, “What’s wrong with your voice?”	0	1	2	3	4
4. My voice sounds creaky and dry.	0	1	2	3	4
5. I feel as though I have to strain to produce voice.	0	1	2	3	4
6. The clarity of my voice is unpredictable.	0	1	2	3	4
7. I try to change my voice to sound different.	0	1	2	3	4
8. I use a great deal of effort to speak.	0	1	2	3	4
9. My voice is worse in the evening.	0	1	2	3	4
10. My voice “gives out” on me in the middle of speaking.	0	1	2	3	4

Part III-E					
1. I am tense when talking to others because of my voice.	0	1	2	3	4
2. People seem irritated with my voice.	0	1	2	3	4
3. I find other people don't understand my voice problem.	0	1	2	3	4
4. My voice problem upsets me.	0	1	2	3	4
5. I am less outgoing because of my voice problem.	0	1	2	3	4
6. My voice makes me feel handicapped.	0	1	2	3	4
7. I feel annoyed when people ask me to repeat.	0	1	2	3	4
8. I feel embarrassed when people ask me to repeat.	0	1	2	3	4
9. My voice makes me feel incompetent.	0	1	2	3	4
10. I am ashamed of my voice problem.	0	1	2	3	4

VHI = _____

RSI

Within the last month how did the following problems affect you?
0 = no problem 5 = severe problem

1. Hoarseness or a problem with your voice	0	1	2	3	4	5
2. Clearing your throat	0	1	2	3	4	5
3. Excess throat mucous or postnasal drip	0	1	2	3	4	5
4. Difficulty swallowing food, liquids, or pills	0	1	2	3	4	5
5. Coughing after you ate or after lying down	0	1	2	3	4	5
6. Breathing difficulties or choking episodes	0	1	2	3	4	5
7. Troublesome or annoying cough	0	1	2	3	4	5
8. Sensation of something sticking or a lump in your throat	0	1	2	3	4	5
9. Heartburn, chest pain, indigestion or stomach acid coming up	0	1	2	3	4	5

RSI = ____

GCI

Within the last month how did the following problems affect you?

0 = no problem **5 = severe problem**

1. Speaking took extra effort	0	1	2	3	4	5
2. Throat discomfort or pain after using your voice	0	1	2	3	4	5
3. Vocal fatigue - voice weakened as you talked	0	1	2	3	4	5
4. Voice cracks or sounds different	0	1	2	3	4	5

GCI = _____

QLI

Within the last month how often…
0 = Never **5 = All the time**

1. Did you clear your throat before speaking	0	1	2	3	4	5
2. Did throat discomfort/ pain interfere with normal activities	0	1	2	3	4	5
3. Did you limit the time spent talking due to voice problems	0	1	2	3	4	5
4. Did coughing interfere with work or other activities	0	1	2	3	4	5
5. Did breathing problems interfere with work or other activities	0	1	2	3	4	5
6. Did you have problems swallowing food, liquid or pills	0	1	2	3	4	5

QLI = _____

VOCAL PERFORMERS TO COMPLETE THIS SECTION ONLY:

In what capacity do you use your voice?

- Singer
- Actor
- Presenter (TV/radio/sports)

Detail voice problem:

- Hoarseness
- Loss of quality
- Breathiness
- Fatigue (voice tires or changes quality after singing for short periods)
- Loss of range: high low
- Difficulty with passagio (transition voice)
- Prolonged warm up time
- Change in classification (e.g. lowered from soprano to mezzo)
- Pain when singing
- Tickling or choking while singing
- Problems singing loud
- Problem singing soft
- Voice worse in the morning
- Voice worse at the end of the day

What other jobs do you do in addition to performing? ______________________

Does this involve extensive voice use? ______________________

Have you had training for your speaking voice? Yes No

Acting voice lessons (detail) ______________________

Speech therapy (detail) ______________________

____

Have you had training for your singing voice? Yes No

How long have you been with your present teacher? ______________________________

Teachers name & contact ____

List previous teachers & length of training ______________________________________

____

Do you have an important performance soon? ___________________________________

Do you warm up routinely before singing? _____________________________________

What types of music do you sing? ____

Do you regularly sing in a sitting position (e.g. behind a piano or drum)? _____________

<u>MEMBER'S DETAILS</u>

TITLE ______________________**SURNAME**____

INITIALS_____________________**ID NUMBER**______________________________________

POSTAL ADDRESS ____

____

PHYSICAL ADDRESS ____

____

EMPLOYER____

TEL (H)____

(W)____

CELL____

PATIENT CELL:____

MEDICAL AID _____________________________________

NUMBER___________________________

MEDICAL AID PLAN/ OPTION ____

<u>PATIENT DETAILS</u>

SURNAME ____

FIRST NAME ______________________________________

SEX __________**DATE OF BIRTH**____________________**I.D #** _______________________

RELATIONASHIP TO MAIN MEMBER: ____

DEPENDENT CODE (IF APPLICABLE): ____

(DAD NAME & CELL): ____**<u>(if applicable)</u>**

(MOM NAME AND CELL): ____**<u>(if applicable)</u>**

REFERRING DOCTOR ____

ALTERNATE CONTACT NAME AND TEL ______________________________

____

I accept personal liability for payment of the account in spite of medical aid cover. In addition, I will be liable for any legal costs incurred in the recovery of unpaid accounts.

SIGNATURE……………………………………DATE…………………………………………………..

Appendix D: Questionnaire

Patient Perceptions of Use of Confidential Voice Technique

Biographical Information:
Age:________________________ **Gender:**________________________________
Race:________________________ **Research Code:**__________________________

1. What is your understanding of confidential voice technique? Please describe the technique as you understand it below.
____
____
____
____
____

2. How do you feel your voice changes when you use the confidential voice technique?
____
____
____
____

3. Do you think you could employ the technique in your everyday communication for the prescribed time period? If your answer is no, please explain why below.
☐Yes
☐No
____
____
____
____

4. What do you understand regarding the benefits and/or limitations of the confidential voice technique?
____
____
____
____

5. What is your understanding of why the confidential voice technique was prescribed for your voice problem?
____
____
____
____

Raw Data for Acoustic Analysis

Raw Data for Aerodynamic Measures

Table 16: Results of the SERF for each of the participants with and without the Confidential Voice technique alongside their vocal problem

Appendix H: Ethical Clearance Certificate