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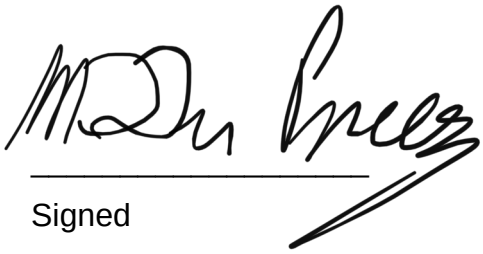
THE PATTERN OF PRESENTATION AND MANAGEMENT OF FASCIAL SPACE INFECTIONS AT CHARLOTTE MAXEKE ACADEMIC HOSPITAL

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A research report submitted in fulfilment of the requirements for the degree of MDENT (MFOS) to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg

DECLARATION

I, Malcolm du Preez declare that this research report is my own work. It is being submitted for the degree of MDENT (MFOS) to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University



Signed

20 ..... day of Oct 2020

ABSTRACT

Purpose: The purpose of this study was to determine the major causes of fascial space infections as well as the pattern of distribution. This study describes the social, demographic and clinical characteristics of the affected patients as well as the incidence of fascial space infections and the extent of treatment received.

Study design: This is a retrospective study evaluating all patients admitted to the Maxillofacial and Oral surgery department at Charlotte Maxeke Johannesburg Academic Hospital from 1 September 2015 - 31 August 2017.

Results: A total of 202 patients were included in the study with a male dominance of 68.32% and a mean age of 34.13 years ranging from 16 – 84 years. All patients were treated according to the guidelines proposed by Peterson which included incision and drainage with the administration of antibiotics. An odontogenic cause for the fascial space infection was determined in 157 cases (77,72%) whilst non-odontogenic causes accounted for 45 cases (22.28%). The fascial spaces involved presented either in isolation or in combination with other spaces and the submandibular space was most commonly involved (64 cases), followed by the subperiosteal space (55), buccal space (40), submasseteric space (35), sublingual and submental spaces (31 each). 59 patients had involvement of 2 or more fascial spaces. Ludwig's angina was recorded in 14 cases. Mandibular third molars were directly or indirectly involved in 146 cases (72.27 %) when odontogenic and non-odontogenic causes were considered. Six antibiotics were effective in the treatment of the patients either in isolation or in combination with another antibiotic. Of the 202 patients that were admitted with fascial space infections, 201 were discharged home following a mean hospital stay 4.93 days ranging from 1 day to 29 days and 1 patient demised.

Conclusion: Fascial space infections are a serious risk to patient's health and life and needs extensive surgical as well as medical treatment in order to reverse the condition. The major cause of fascial space infections at CMJAH was sepsis associated with third molars occurring at a mean age of 34.13. We concluded that fascial space infections are of great concern and the incidence of 19.39% is significant. HIV prevalence in the population may also be a contributing factor. It is suggested that the prophylactic removal of suspicious mandibular

third molars at a younger age may significantly improve outcomes by decreasing the incidence and severity of fascial space infections. This will in turn reduce the usage of scarce resources to treat these conditions and prevent significant morbidity to patients whilst improving the overall economic impact of the hospitalization.

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CHAPTER 1: INTRODUCTION

Fascial space infections as a serious disease and ability to cause death has been known about since early on in man's existence (T Wilwerding, 2005). In the pre-antibiotic but modern surgical era, deaths due to odontogenic infections ranged from 10 - 40 % (TT Thomas, 1908). Odontogenic infections are common and can be treated by local medical - surgical means, although in some cases they may become more complicated and result in significant morbidity and mortality. The discovery and use of penicillin have decreased these deaths dramatically in combination with surgical procedures that involve the evacuation of the sepsis and removal of the cause. Over the last 10 - 15 years there has been a progressive resistance to penicillin reportedly due to incorrect administering of this drug (Jaunay *et al*, 2000).

The following clinical signs are associated with fascial space infection: swelling involving the mid-face, peri-orbital oedema, swelling which crosses the lower border of the mandible, elevated floor of mouth, restricted mouth opening, difficulty in swallowing or breathing, dysphonia, swelling or erythema of the neck, headache, stiff neck, fever and malaise.

The underlying fascial space infections can develop from odontogenic as well as a non-odontogenic cause. Odontogenic infections are the most frequent with 70 - 90 percent originating from pulp necrosis, periodontal disease, pericoronitis, granulomas, apical cysts or complications of dental procedures. Non-odontogenic infections are associated with mandibular fractures, submandibular sialoadenitis, infections of the salivary glands, tumours or cystic lesions and infections of pharyngeal or tonsillar origin (Letelier *et al.*, 2017).

The host resistance or its impairment also determines the nature of spread of infections. Immunocompromised states such as HIV/AIDS, haematological neoplasia or systemic diseases such as diabetes are risk factors for the sudden spread of infection (Miller & Dobson, 1998).

Diabetic patients are at higher risk of developing these infections as they have reduced neutrophil activity and compromised blood supply that decreases perfusion of antibiotic agents to the target sites. Together with the metabolic derangements caused by the diabetic state, the infection accelerates.

CHAPTER 2: LITERATURE REVIEW

2.1. Fascial space infections

The specific anatomy of the jaws is quite complex as there are several muscles attaching to the bones which enable speaking, swallowing and eating. Fascial spaces are potential fascia-lined spaces between anatomical structures, which cannot be detected in a healthy individual. Maxillofacial infections cause these potential fascial spaces to be eroded or distended by purulent exudate (Peterson *et al*., 2004).

An accurate understanding of the arrangement of cervical fascia and its associated compartments is essential for differential diagnosis, predicting the spread of disease and surgical management (Peterson *et al*., 2004).

The submental space is bordered by the anterior bellies of the digastric muscles below the symphysis of the mandible. The roots of the mandibular incisors may extend into this space. The sublingual space is bordered by the mucosa of the floor of the mouth and the mylohyoid muscle. The roots of the mandibular premolars and molars point towards this space. The sublingual and submandibular spaces are divided by the mylohyoid muscle, but these two spaces can communicate with one another at the posterior edge of the muscle.

The submandibular space is bordered by the mylohyoid muscle, superficial fascia, medial edges of the mandible border and the platysma. Infection can easily spread between these spaces as there is no restriction at the posterior edge of the mylohyoid muscle. From there it can spread into the deep cervical spaces, called the retropharyngeal and prevertebral spaces (Peterson *et al*., 2004).

The buccal space is bordered by the buccinator muscle and facial skin. Both mandibular and maxillary molar roots can drain into this space. The masseteric space is located between the ramus of the mandible and the medial aspect of the masseter muscle.

The pterygomandibular space is bordered by the medial edge of the mandible and the medial pterygoid muscle, the upper part of the pterygomandibular space forms the infratemporal space. The peritonsillar space is located around the palatine tonsil between the pillars of the pharynx. The canine space is located between the levator anguli oris and levator labii

superiorii muscles and the maxillary canine roots are present in this region (Peterson *et al*., 2004).

The lateral pharyngeal, retropharyngeal and prevertebral spaces are considered as the deep cervical spaces and all of them extend from the base of the skull inferiorly to different levels. The lateral pharyngeal space lies lateral to the pharynx and is continuous with the retropharyngeal space which extends from the base of skull to the hyoid bone. The retro-pharyngeal space extends to the level of vertebrae C7 or T1 where the alar fascia fuses with the buccopharyngeal fascia. The prevertebral space is separated from the retropharyngeal space by the alar layer of the prevertebral fascia and this space extends to the level of the diaphragm. The retropharyngeal and prevertebral spaces are located near the mediastinum (Peterson *et al*., 2004).

Table 1: Borders of the Deep Spaces of the Head and Neck

			Borders			
Space	**Anterior**	**Posterior**	**Superior**	**Inferior**	**Superficial or Medial***	**Deep or Lateral#**
Buccal	Corner of mouth	Masseter m., pterygomanibular space	Maxilla, infraorbital space	Mandible tissue and skin	Subcutaneous	Buccinator m.
Infraorbital	Nasal Cartilages	Buccal space	Quadratus labii superioris m.	Oral mucosa	Quadratus labii superiorism.	Levator anguli oris m., maxilla
Submandibular	Ant. belly digastric m.	Post. belly digastric m., stylohyoid, stylopharyngeus mm.	Inf. and med.surfaces of mandible	Digastric tendon	Platysma m., investing fascia	Mylohyoid, Hyoglossus, Sup. constrictor mm.
Submental	Inf. border of mandible	Hyoid bone	Mylohyoid m.	Investing fascia	Investing fascia	Ant. bellies digastric m.#
Sublingual	Lingual surface of mandible	Submandibular space	Oral mucosa	Mylohyoid m.	Muscles of tongue*	Lingual surface of mandible#
Pterygomandibular	Buccal space	Parotid gland	Lateral pterygoid m.	Inf. border of mandible	Med. pterygoid m.*	Lingual surface of mandible#
Submassenteric	Buccal space	Parotid gland	Zygomatic arch	Inf. border of mandible	Ascending ramus*	Masseter m.#
Lateral Pharyngeal	Sup. and Mid. pharyngeal constrictor mm.	Carotid Sheath and scalene fascia	Skull Base	Hyoid bone	Pharyngeal constrictors and retropharyngeal space*	Medial pterygoid m.#
Retro Pharyngeal	Sup. and Mid. pharyngeal constrictor mm.	Alar fascia	Skull base	Fusion of alar and prevertebral fascia at C6 - T4	-	Carotid sheath and lateral pharyngeal space#
Pretracheal	Sternothyroid-thyroidhyoid fascia	Retro-pharyngeal space	Thyroid cartilage	Superior mediastinum	Sternothyroid-thyroidhyoidfascia	Visceral fascia over trachea and thyroid gland

adapted from Flynn.,2004

Ant = anterior, Inf = inferior, Sup = Superior, Post = posterior, lat = lateral, m. = muscle, mm. = muscle medial, mid = middle,
*= Medial border, # = Lateral border

Table 2: Relations of Deep Spaces in infections

Spaces	Likely causes of sepsis	Contents	Neighbouring spaces	Surgical approach
Buccal	Upper bicuspids, Upper molar, Lower bicuspids	Parotid duct, Facial a. and v., Buccal fat pad	Infraorbital, Pterygomandiblar, Infratemporal	Intraoral (small), Extraoral (large)
Infraorbital	Upper bicuspids	Angular a. and v., Infraorbital n.	Buccal	Intraoral
Submandibular	Lower molars	Submandibular gland, Facial a. and v., Lymph nodes	Sublingual, Submental, Lateral pharyngeal, Buccal	Extraoral
Submental	Lower anteriors, fracture of symphysis	Ant. Jugular v., lymph nodes	Submandibular	Extraoral
Sublingual	Lower bicuspids, Lower molars, Direct trauma	Sublingual glands, Wharton's ducts, Lingual n., Sublingual a. and v.	Submandibular, Lateral pharyngeal, Visceral (trachea and oesophagus	Intraoral, Extraoral
Pterygomandibular	Lower third molars, Fracture of angle of mandible	Mandibular div. of trigeminal n., Inf. alveolar a. and v.	Buccal, Lateral pharyngeal, Submassenteric, Deep temporal, Parotid, Peritonsillar	Intraoral, Extraoral
Submasseteric	Lower third molars, Fracture of angle of mandible	Masseteric a. and v.	Buccal, Pterygomanibular, Superficial temporal, Parotid	Intraoral, Extraoral
Infratemporal and deep temporal	Upper molars	Pterygoid plexus, Internal maxillary a. and v., Mandibular div. of trigeminal n., Skull base foramina	Buccal, Superficial temporal, Inf. petrosal sinus	Intraoral, Extraoral
Superficial temporal	Upper molars, Lower molars	Temporal fat pad, Temporal branch of facial n.	Buccal, Deep temporal	Intraoral, Extraoral
Lateral Pharyngeal	Lower third molars, Tonsillar infection neighbouring spaces	Carotid a., Internal jaguar v., Vagus n., Cervical sympathetic chain	Pterygomandibular, Submandibular, Sublingual, Peritonsillar, Retropharyngeal	Intraoral, Extraoral
	adapted from Flynn.,2004			
	a = artery, v = vein, n = nerve, div. = division, inf. = inferior. ant =anterior			

2.2. Anatomic routes for local spread of odontogenic infection

Odontogenic infections usually originate from an acute alveolar abscess, such as in apical periodontitis. Thereafter it spreads through the bone and periosteum to form a soft fluctuant swelling. If the host cannot contain the infection or treatment is not available the abscess erupts into the oral cavity forming a fistula and the disease becomes chronic. The chronic state can however revert to become acute if the drainage becomes interrupted.

Local infections spread through a path of least resistance which is determined by the thickness of the bone and the associated muscle attachments. If the roots point to deep structures, the infection tends to spread to the fascial spaces described earlier. These infections also affect the lymphatic system and lymphadenitis is a common finding. Fascial space infections spread to deeper spaces simultaneously, leading to airway compromise and life-threatening complications (Peterson *et al*., 2004).

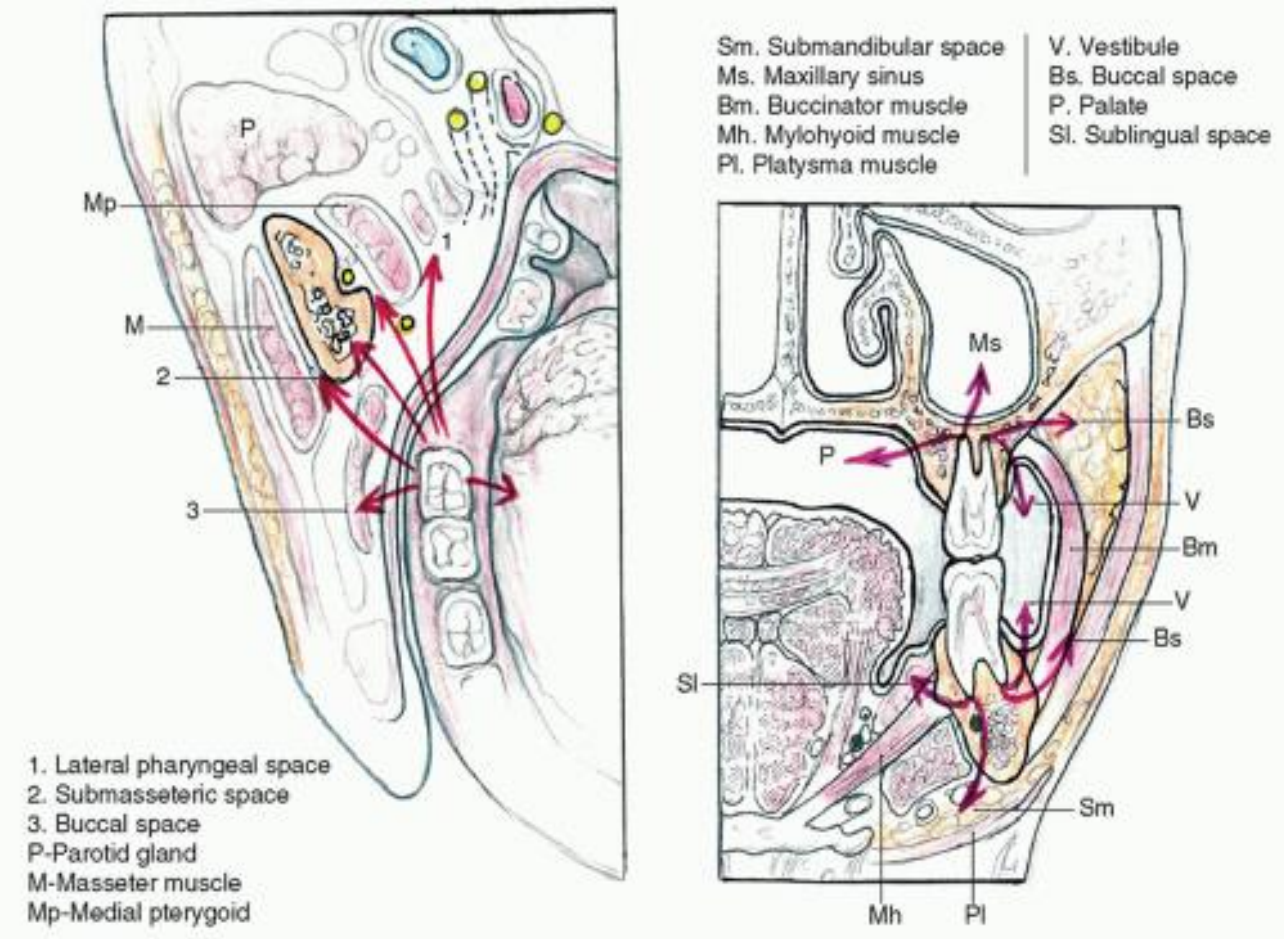


Figure 1: Routes of spread of odontogenic infections (Doerr, 2016)



Figure 2: A buccal space abscess



Figure 3: Drains placed post incision and drainage of a submandibular, sublingual and submental abscess

2.3 Aetiology of fascial space infections

2.3.1 Odontogenic causes

The vast majority of commensal bacteria are harmless and or beneficial to the host and relatively few bacteria in the oral cavity are highly virulent. The classic signs and symptoms of infection are local tenderness, redness, swelling, heat and pain. Odontogenic infections originate from local compromised dental disease, such as apical periodontitis, local abscess formation, pericoronitis, gingivitis or periodontitis and alveolar osteitis (Grönholm L., 2012).

Odontogenic bacterial infection is still reported as being the most common cause of fascial space infections. Amaidas (1990) studied the pathogenesis of cervicofacial infections at the University of the Western Cape over a period of 3 years and showed a prevalence of 56.7% for odontogenic only causes and 21.7%, where the tooth was left in the line of a jaw fracture.

In a 4-year prospective study of severe odontogenic infections by Flynn et al. (2006a), they found that 65% of odontogenic abscesses were caused by caries, 22% by pericoronitis and 22% by periodontal infections. These findings were supported by other studies, (Woods, 1978; Morey et al., 1984; Guralnick, 1984) which concluded that odontogenic infections are the most common cause of orofacial sepsis.



Figure 4: Panelipse revealing impacted mandibular 3rd molars and carious 2nd and 3rd mandibular molars

2.3.2 Trauma related causes

Jaw fractures were reported to be the second most common cause of orofacial sepsis (21.7%) (Amaidas,1990). Bacteria enter the subcutaneous tissues when the skin and or mucosal protective barrier has been breached by the insult of trauma. The location and mechanism of injury will often determine the flora that initiates the infection. Fascial space infections can also develop when haematomas that develop post-trauma become secondarily infected.



Figure 5: Buccal space and preseptal orbital abscess from infected haematoma post assault

2.3.3 Nasal and paranasal causes

Sinusitis is often divided into acute and chronic maxillary sinusitis, infective rhinitis, frontal and sphenoid sinusitis. This is due to the differences in the causative organism and infection management. Maxillary sinusitis is divided into acute community-acquired bacterial sinusitis, chronic and nosocomial sinusitis (Winther et al., 1998).

Clinical signs of sinusitis include pain on percussion of areas overlying the involved sinus, dull to throbbing pain, postnasal discharge, oedema of the middle and inferior nasal turbines, polyp formation and nasal congestion (Leung and Katial., 2008).

The microbiological flora found in sinusitis is the same as that affecting fascial space infections. However, the majority of acute sinusitis is caused by viruses. Bacteria tend to colonise post-viral infections due to obstruction of the sinus drainage by oedema and inhibited mucociliary function.

Brain abscesses, subdural empyema or cavernous sinus thrombosis are rare complications of persistent sinusitis and the spread occurs via direct extensions through the thin layers of bone or via emissary veins (Brook., 2007).

2.3.4 Cutaneous infections

Cutaneous infections can be subdivided into bacterial, fungal, protozoal and viral causes. The most common bacterial cause is folliculitis, consisting of itchy, tender papules or pustules. This infection of the hair follicle may be superficial or deep, with the infected follicle hair removed easily. A deeper infection may lead to the development of a furuncle or boil, which is a localised abscess of the follicle with some destruction of its walls. A carbuncle forms when a group of furuncles coalesce into a large abscess. Midfacial furuncles have a potential risk of developing cavernous sinus thrombosis owing to extensive communications between the facial veins and the orbital venous plexuses. Causative organisms are usually *S. aureus, C. albicans* and *P. aeruginosa*.

Folliculitis is a relatively self-limiting condition and generally does not need specific antimicrobial therapy. Furunculosis and carbuncles should be treated with systemic antibiotics mainly directed at *S. aureus*. Carbuncles usually require surgical drainage as well as antibiotic treatment (Kumar and Clarke, 1998).

2.3.5 Tuberculosis

Orofacial tuberculosis (TB) is a rare manifestation of extra-pulmonary TB, occurring in approximately 0.1–5% of all TB infections. It can be primary or secondary. The primary form is rare and more commonly found in children and adolescents. In contrast, the secondary form is more common and is usually seen in middle-aged and elderly patients. Orofacial TB can involve any area of the oral cavity and associated structures such as the tongue, palate, lips, oral mucosa, jaw bones, sinuses and temporomandibular joint. Tuberculosis in the orofacial region often manifests as a lymphadenitis, which may then break down with abscess and fistula formation (scrofula). It may also manifest as osteomyelitis with varying amounts of suppuration, often affecting the vertebrae or mandible (Bansal *et al*., 2015).

2.3.6 Actinomycosis

Actinomycosis is a rare and slow progressive bacterial disease usually caused by *Actinomyces* spp., most commonly *A. israelii*. *Actinomycetes spp.* are part of the oral microbiota as well as the oropharynx, gastrointestinal tract and pelvic regions. Due to their low virulence they are harmless as long as they are on the surface of the oral mucosa (Wong et al., 2011). The infection is characterised by the formation of painful abscesses with a suppurative discharge that contains yellow sulphur granules. It usually begins in an area of trauma or a previous extraction site and then spreads typically by direct extension, not following fascial planes, rather by direct extension and often forming numerous sinus tracts (Miller and Haddad, 1998).

2.3.7 Acute Suppurative Lymphadenitis

Cervical lymphadenitis refers to inflammation of one or more lymph nodes of the neck.
Acute suppurative lymphadenitis most commonly occurs in children under four years old due to the inability of the immune system to localise the organism at the site of invasion and allow spreading to lymph nodes with resulting suppuration. The most common lymph nodes affected are the submandibular and jugulodigastric nodes and *Staphylococcus aureus* and group A *Streptococcus* are the most common bacterial pathogens. HIV should be regarded as an aetiological agent (Butler & Baker, 1992).

2.3.8 Cat scratch disease

Cat scratch disease (CSD), also known as cat scratch fever or subacute regional lymphadenitis, is a bacterial infection affecting lymph nodes that drain the sites of inoculation.
It presents as a papule or pustule at the site of a cat bite or scratch that forms three to 14 days after the injury. It usually heals by the time the lymphadenitis forms (draining node/s). Complications are suppuration, conjunctival granuloma (periorbital lesion), and temporary facial paralysis if the lymphoid tissues of the parotid gland is affected.
Bartonella henselae, a gram-negative rod, is considered the principal aetiologic agent and is commonly found in children and adolescents (Bergman *et a*l., 1995).

2.3.9 Osteomyelitis

Osteomyelitis is an inflammation of the cortical and medullary bone, and various forms have been identified. It is most commonly caused by bacterial infection; however, the aetiology remains unclear. Osteomyelitis is seen in patients with local and systemic predisposing factors, such as Diabetes Mellitus, alcoholism, smoking, immunosuppression, previous radiotherapy, malnutrition, malignancy and corticosteroid therapy (Eyrich et al.,2003).

The most common precipitating causes are odontogenic infection and traumatic fracture of the jaws. Other causes, often seen in developing countries, include acute necrotising gingivitis (ANUG) and cancrum oris (noma) (Adekeye and Cornah, 1985).

Staphylococcus and *Peptostreptococcus spp.* are the most common bacteria isolated from osteomyelitic mandibles. Deep fungal infections, mycobacterial infections, syphilis and actinomycosis have the ability to cause osteomyelitis but their occurrences are rare (Suei *et al.*, 2005).

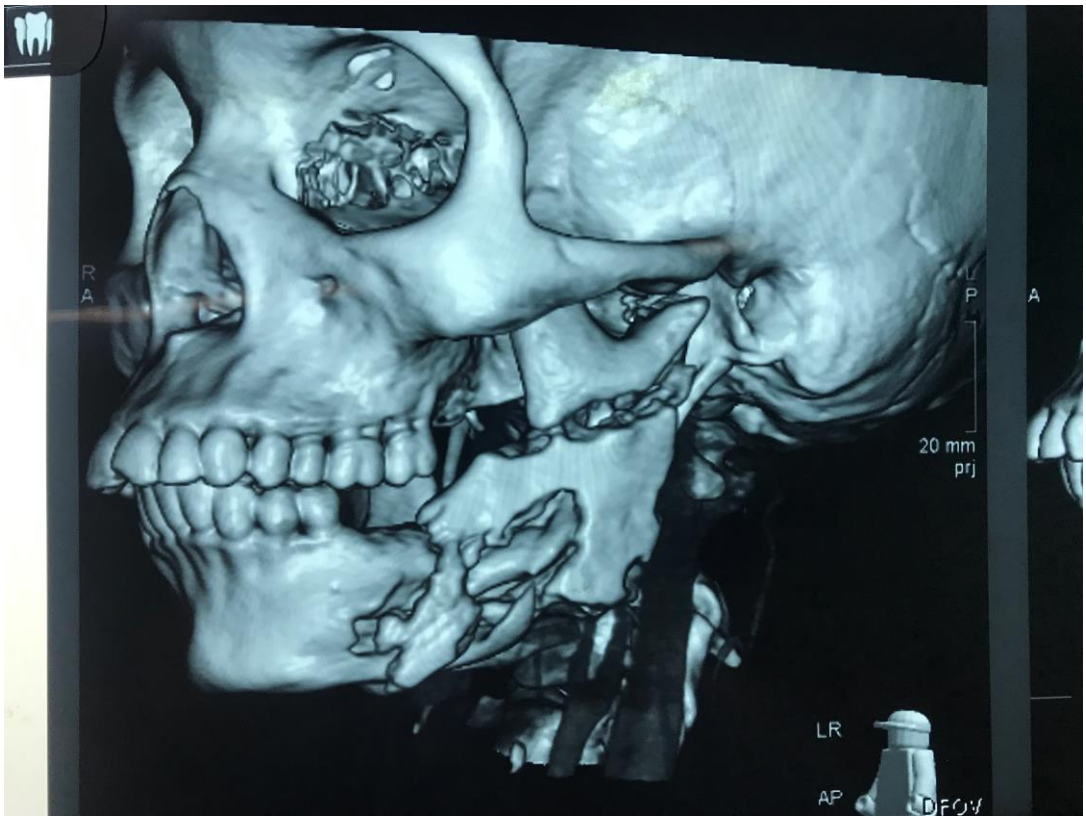


Figure 6: Computed tomography scan illustrating osteomyelitis of the mandible

2.4 Oral microbiology

The oral cavity consists of various microbes that exist in close harmony with the host immune system in a healthy state. The oral cavity is densely colonised with microbes due to its contact with the external environment and resembles colonisations that are similar to the vagina and gastrointestinal tract. The oral cavity consists of non-shedding surfaces, enamel and cementum of teeth and this enables the formation of biofilms with substantial microbial diversity. These microbes colonise the teeth, tongue, gingival sulcus, cheeks, palate and are referred to in the literature as normal flora and consist of bacteria, viruses, fungi and parasites. However, bacteria are the predominant microorganism found in the oral cavity (Dewhirst *et al*, 2010).

Severe infections in the head and neck region are mostly of odontogenic origin and frequently involve a complex polymicrobial mix of aerobes, facultative aerobes and strict anaerobes that work closely together. *Peptostreptococcus, Staphylococcus, Lactobacillus, Prevotella, Treponema, Fusobacterium, Veillonella, Actinomyces, Bacteroide ssp.* and oral *Streptococcus sp*. are frequently associated with infections of odontogenic origin. Multiple studies throughout the world have shown that a variety of microbes are present when severe infections are encountered (Rocha *et al.*, 2015).

Flynn *et al*.,2006 isolated 90 different strains of microorganisms in 37 patients, and of these, 17 were penicillin-resistant.

Sakamoto *et al*.,2000 reported 23 different species, aerobic and anaerobic, collected from 2 patients that suffered from descending necrotising mediastinitis due to odontogenic infections. They found that all of the 23 species were susceptible to carbapenem.

Sakamoto suggested that routine culture and testing is not necessary when minor oral infections appear as other species can easily be found at the infection site which reflect the indigenous microflora of the oral cavity. When fascial space infections occur involving multiple anatomical spaces of moderate to greater severity, or when there is significant medical/immune compromise, the tests become important to the outcome.

2.5 Clinical characteristics of maxillofacial infections

2.5.1 Patient demographics and aetiology

Patients that suffer from odontogenic maxillofacial infections are typically young to middle aged and this has hardly changed over the past decades. Men are more commonly affected than woman (45 - 65%) (Saito *et al*.,2011). Mandibular molars have been identified as the major cause of odontogenic infections, either singular or multiple, and the submandibular space mostly affected, due to the apices of the molar roots being situated below the mylohyoid muscle (Rao *et al*.,2010, Sanchez *et al*., 2011).

Other commonly affected spaces are the buccal space, lateral pharyngeal space, submental space, sublingual space and canine space. Multiple space involvement occurs more frequently than single space involvement (Storoe *et al*., 2001).

2.5.2 Incidence

The incidence of fascial space infections that required hospital care has unfortunately not been well reported in the literature. Carter & Starr in 2006, reported a 47% increase in fascial space infections at the Hull Royal Infirmary Hospital in England between 1999 and 2004. Thomas *et al.*, 2008 reported that the number of fascial space infections between 1998-1999 and 2005-2006 in a British hospital had doubled as a result of patients finding it difficult to access routine and emergency dental care.

Blankson *et al*., 2019 reported that in Ghana the incidence of tooth-related infections per 1000 cases from July 2012 - July 2017 for the years of the review was 8.2, 8.9, 17.7, 17.9 and 27.7.

2.5.3 Sign and symptoms

Trismus, dysphagia, pain, swelling, fever, airway compromise and respiratory distress are common symptoms of severe odontogenic infections. These criteria are the reason for hospital admission and the length of hospital stay that ranges from 3.69 - 8.27 days (Sanchez et al.,2011).

2.6 Management of fascial space infections

Peterson, describes eight steps in the management of odontogenic infections and these will be adopted in the critical analysis of literature in this section.
The eight steps are:

2.6.1. Infection severity

Identify the anatomic location of the infection, determine the rate of progression and the risk of airway compromise.
Flynn *et al*.,1999 developed a scoring system to assess the severity of airway compromise. The scoring system divided the infected anatomic locations into low, moderate, severe and extremely severe sites with a score from 1 - 4 with increasing severity.

Anatomic location and Severity Score

1. Low risk: Subperiosteal, Buccal, Infraorbital, Vestibular fascial space infections
2. Moderate risk: Masseter, Submandibular, Submental, Sublingual, Temporal, Pterygomandibular fascial space infections
3. Severe risk: Lateral pharyngeal, Retropharyngeal, Pretracheal fascial space infections
4. Extremely severe risk: Danger space (alar space), Mediastinum, Intracranial infection

Airway compromise is the major cause of death in severe odontogenic infections and early airway safety and intervention with incision and drainage is the key surgical principle in managing these infections. Often emergency airway procedures such as cricothyroidotomy or tracheostomy are required because fibre-optic assisted intubation is extremely difficult in these severe cases.

Clinical indications of airway compromise include trismus, a stridor may be heard, raised floor of mouth, dysphagia, odynophagia and inability to lie supine. Patients are often postured forward with a chin tilted upwards, gasping for air with the presence of nasal flaring.
Airway compromise can also be assessed with CT scans and lateral neck radiographs but usually a thorough clinical examination will confirm the risk of airway compromise (Flynn T.R., 2004).



Figure 7: Patient with a compromised airway and nasal flaring as result of an odontogenic infection

2.6.2. Host defences

Patients who are immunocompromised are at higher risk to developing an infection and the severity of the infections tends to require more complicated and aggressive management. Several diseases and treatments compromise the immune system and therefore more aggressive management strategies should be implemented in these individuals to facilitate earlier recovery (Neville *et al*.,2002). Factors that are associated with immune system compromise are as follows:

- diabetes
- steroid therapy
- organ transplants
- malignancy
- chemotherapy
- chronic renal disease
- malnutrition
- alcoholism
- end-stage AIDS (Flynn, 2004).

2.6.3. Setting of care

Flynn T.R., (2004) suggested six factors that warrants hospital admission for fascial space infections. They are:

- temperature > 38.3ºC
- dehydration
- threat to airway or vital structures
- infection in moderate or high severity anatomic spaces
- need for general anaesthesia
- need for in-patient control for systemic disease.

2.6.4. Surgical treatment

Airway security is the primary concern followed by incision and drainage with removal of the causative agent. Clinical diagnosis with thorough knowledge of anatomy is important to appropriately make incisions and to prevent damage to vital structures. Gravity - assisted drainage should be created wherever possible and these incisions should be planned within relaxed tension lines of the face and neck. Different types of fascial space infections are drained with different incisions (Flynn, 2004).

2.6.5. Medical care

Medical support is essential with severe odontogenic infections. Rehydration, ensuring adequate nutrition and controlling the fever are the goals (Miloro et al., 2004). Flynn *et al*., (1999) has shown that initial temperature is a significant predictor of length of hospital stay in severe odontogenic infections. Fever below 39.4ºC promotes phagocytosis, increases blood flow to affected areas, raises the metabolic rate and enhances antibody function. Fever of >39.4ºC drives the body to a catabolic state, depleting reserves and making immune and metabolic functions less effective. Fever should therefore be managed either medically or with local measures. Fever also increases metabolic demand and therefore it is important to replace daily fluid losses to maintain normal hydration and electrolyte balances. Daily fluid losses comprise of sensible, insensible and additional losses. Sensible losses are primarily due to sweating and are increased by 250ml per degree of fever. Insensible losses from the lung and skin increase by 50 - 75ml per degree of fever. Additional losses are associated with diarrhoea, vomiting and fistulas. (Marino, 2007)

2.6.6. Antibiotic selection

Antibiotics should be used as adjuncts to surgery for it is well known that antibiotics alone will not cure the infection. It is therefore important to select the appropriate antibiotic for the pathogen involved. Penicillin has proven to be effective in treating odontogenic infections and is therefore the first line of antibiotic used. Host factors include allergy, previous antibiotic therapy, immune compromise, intolerance to the antibiotic, age and pregnancy.
It is important to use bacteriocidal rather than bacteriostatic antibiotics in patients who are immune compromised for they are unable to mount a response to the invading pathogen (Flynn and Halpern, 2003).

2.6.7. Antibiotic administration

It is essential to select the correct antibiotic that is effective against all the pathogens that are likely to be present in the specific condition. The antibiotic is only effective when the concentration of the antibiotic is high enough in the area of infection (Flynn and Halpern, 2003).
It has been reported that Clindamycin reaches up to 33% of its serum concentration in an abscess – the highest concentration within an abscess, allowing it to be very effective against odontogenic infections. It is important to remember that clindamycin is a bacteriostatic agent and its use should be reconsidered in an immune compromised patient. Best bone penetration is achieved by tetracyclines, clindamycin and fluoroquinolones (Karsten, 1999).

The pharmacokinetics of the antibiotic is the reflection of the potency of the drug and is determined by the minimum inhibitory concentration (MIC). It is usually expressed as MIC50 and MIC90. This is the minimum concentration of an antibiotic required to kill 50% (MIC50) or 90% (MIC90) of the pathogens.

In time–dependent antibiotics (β – lactam group and vancomycin), it is essential that the serum concentration is above the MIC for at least 40% of the dosage interval. In concentration–dependent antibiotics (fluoroquinolones and aminoglycosides), the efficacy is dependent on the serum concentration ratio of that antibiotic to kill 50% (MIC50) or 90% (MIC90) of pathogens.

Empiric antibiotics relate to administration of an antibiotic that will most likely be active against the pathogens before culture and sensitivity has been tested. These empiric antibiotics are determined by previously studied microscopy and sensitivity of pathogens in specific conditions.

2.6.8. Patient evaluation

Improvement of symptoms should be seen within 48 hours post - treatment with empiric antibiotics, medical supportive care and surgical intervention. The physiological response to treatment can be measured by improvement of symptoms such as swelling and pain, decrease in inflammatory markers and improvement in vital signs i.e. temperature, heart rate, respiratory rate, blood pressure and urine output (Marino, 2007).

Failure to respond optimally can be attributed to the following:

- inadequate surgery
- depressed host defences
- presence of foreign body
- antibiotic problems - incorrect bacterial diagnosis
- dose of antibiotic too low - drug not reaching site
- antibiotic not administered

When patients fail to respond to treatment after 48 hours, patients need to be re- examined thoroughly and care should be taken not to overlook medical conditions such as tuberculosis, malaria and bacteraemia. It is important to review microscopy and sensitivity of the pus samples and reconsider change of antibiotics with or without surgery. Patients should also be rescanned to rule out any missed collections from the first surgery, new fascial space collections or distant spread of infection. Blood tests should be repeated to assess the pathophysiology (Marino, 2007).

2.7 Criteria for hospital discharge

The patient should be extubated and recovered from general anaesthesia and paralysing agents. Patient's vital signs must be within normal ranges with temperature below 38ºC for 24 hours and should maintain oxygen saturation of more than 93% unaided. Patients should be able to swallow and tracheostomy decannulated if present. All drains should be removed with minimal to no drainage present with a marked decrease in swelling (Marino, 2007).

Ideal treatment would include the following time frames and interventions leading to successful discharge. The first 24hours - the patient is admitted and incision and drainage should have been performed. The next 24 - 48hours drains are monitored and the correct antibiotics administered. 48hours after surgery the drains are removed and the patient evaluated for the next 24 hours. Once all clinical markers have returned to normal the patient can be discharged home.

2.8 Complications

Ludwigs angina was first described by Wilhelm Frederick Von Ludwig in 1836 and it refers to a bilateral cellulitis of the submandibular, sublingual and submental spaces. Odontogenic infections account for almost 70% of these conditions. It is a polymycrobial infection that progresses rapidly to cause airway obstruction and mediastinitis (Costain *et a*l.,2011). The mortality rate of these patients with mediastinitis is as high as 40% and intensive care post-surgical management is obligatory.

Necrotising fasciitis is a rapidly spreading soft tissue infection with gas formation which spreads via the fascial planes of the head and neck causing widespread tissue destruction. It is most prevalent in patients that are immunocompromised and who received delayed treatment (Treasure *et al*.,2010).

Cavernous sinus thrombosis is a rare but dangerous complication of infection in the head region. The infection spreads via the interconnecting venous system and needs aggressive and emergency surgical treatment to prevent permanent visual loss or brain abscesses (Colbert *et al*., 2011).



Figure 8: Clinical presentation of a Ludwigs angina



Figure 9: Clinical presentation and surgical intervention in necrotising fasciitis

CHAPTER 3: METHODOLOGY

3.1 Rationale of this study

Anecdotal evidence has suggested that fascial space infection contributes significantly to the workload of Maxillofacial and oral surgery registrar training, at Charlotte Maxeke Johannesburg Academic Hospital. Currently no scientific evidence exists to supports this hypothesis. Factors associated with these severe septic events have also not been determined.

3.1.1 Aim

The aim of this study is to determine the pattern of presentation and management of fascial space infections at the Charlotte Maxeke Academic Hospital.

3.1.2 Hypothesis

The hypothesis of this study is that severe maxillofacial sepsis contributes significantly to the patient load treated at the Charlotte Maxeke Johannesburg Academic Hospital and that impacted third molars are a major aetiological agent in the development of fascial space infections.

3.1.3 Objectives

- To describe social, demographic and clinical characteristics of patients presenting with fascial space infections
- to determine the most common cause of fascial space infections in our centre
- to determine the incidence of fascial space infections in relation to all cases admitted for surgery in the MFOS department at CMJAH over two years
- to evaluate the association between social, demographic and clinical characteristics and possible comorbidities (HIV, DM) with fascial space infections
- to determine the association between patients who required a change in antibiotic therapy for successful resolution of the sepsis with their social, demographic and clinical characteristics.

3.2 Materials and methods

3.2.1. Study design

This is a retrospective cross-sectional study of patients treated for fascial space infections in the Department of Maxillofacial and Oral Surgery, Charlotte Maxeke Johannesburg Academic Hospital.

3.2.2. Study setup

This study was conducted in the Department of MFOS, CMJAH. This hospital is the main referral/tertiary hospital in Johannesburg and this department performed approximately 1700 surgical procedures in 2016 and 1800 surgical procedures during 2017

3.2.3. Study population

Inclusion criteria:
The inclusion criteria for this study were the medical records of patients that were admitted for management of fascial space infections that required incision and drainage.

Exclusion criteria:
All medical records that did not have the essential information for the study were excluded.

3.2.4. Data collection

Medical records obtained from all patients admitted to the Department of Maxillofacial and Oral Surgery at the Charlotte Maxeke Academic Hospital with major fascial space sepsis from 1 July 2015 - 1 July 2017 were reviewed.

The information that was collected included demographic data (age, gender), social habits, comorbidities, fascial space(s) involved, possible aetiology, antibiotics used and complications. A data sheet was used to document the information (Annexure A).

3.2.5. Data / statistical analysis

The information from the data sheets was entered into a Microsoft Excel spread sheet and imported into Statistica (version 15.2) statistical software. Socio - demographic and clinical characteristics of the study population are described as follows.

Categorical variables such as gender, comorbidities and social habits are described using frequencies, percentages and appropriate tables.

Continuous variables such as age and number of fascial spaces involved are reported as a mean ± standard deviation or median inter-quartile range. Inter-quartile range is the 25 – 75^{th} percentile.

Continuous variables that are normally distributed are presented as mean ± standard deviation, and variables that are not normally distributed are presented as median (inter-quartile range).

The number of fascial space infections admitted were divided by the total number of all patients admitted for surgery in the MOFS department, to obtain the incidence per surgical case in the hospital.

The association between categorical variables such as gender, comorbidity, fascial spaces and presence of complications were determined using a Pearsons's Chi Square test.

Comparison of continuous variables among those that developed complications and those that had no complications, or those that required a change in the antibiotic regimen compared to those that did not require an antibiotic change were conducted by using the Student's t - test if the continuous variable was normally distributed. The Mann Whitney U test was used if the continuous variable was not normally distributed.

CHAPTER 4: RESULTS

During 1 September 2015 to 31 August 2017, two hundred and two patients with fascial space infections were admitted to the Maxillofacial and Oral surgery unit at Charlotte Maxeke Johannesburg Academic Hospital. All the patients admitted fulfilled the inclusion criteria and therefore the study population consisted of two hundred and two patients. All patients had incision and drainage done with the administration of antibiotics.

Patients ages ranged from 16 – 84 years of age. The age group between 20 - 39 years of age was mostly affected with a mean age of 34.13 years. Males were more affected (68.32%) than females (31.68%). Age and sex distribution are recorded in Table 3.

Comorbidities recorded are presented in Table 4.

Smoking and alcohol consumption prevalence by gender is recorded in Table 5.

Table 3: Patient Characteristics

Age in years	Frequency n	Female n	Male n	Percentage total
10 - 19	9	4	5	4.46
20 - 29	77	25	52	38.12
30 - 39	62	22	40	30.69
40 - 49	28	3	25	13.86
50 - 59	17	7	10	8.42
60 >	9	3	6	4.46

Table 4: Comorbidities

Comorbidity	Frequency	Percentage %
Healthy	158	78.22
Asthma	3	1.49
Cerebral palsy	1	0.5
Diabetic	7	3.47
Epilepsy	1	0.5
Hypertensive	4	1.98
Hypertensive and RVD	1	0.5
Penicillin allergy	1	0.5
Pregnant & RVD	1	0.5
RHF	1	0.5
RVD	24	11.88

Table 5: Gender, smoking and alcohol prevalence

Gender	Frequency n 202	Smoking	Alcohol	Gender %	Smoking %	Alcohol %
Female	64n	17n	26n	31.68%	8.42%	12.87%
Male	138n	81n	90n	68.32%	40.1%	44.55%

The fascial spaces involved, either presented in isolation or in combination with other spaces and the submandibular space was involved in 64 cases, followed by the subperiosteal space (55), buccal space (40), submasseteric space (35), sublingual and submental spaces (31 each). 59 patients had involvement of 2 or more fascial spaces. Ludwig's angina was recorded in 14 cases (Table 6).

Table 6: Frequency of fascial spaces involved

Fascial spaces	Frequency	Percentage
Buccal	27	13.37
Buccal & Submasseteric	4	1.98
Buccal & Sublingual	1	0.5
Canine fossa	4	1.98
Lip abscess	3	1.49
Ludwig's angina	14	6.93
Medial Pterygoid & Submasseteric	1	0.5
Scalp & Temporal	1	0.5
Submandibular	23	11.39
Submandibular & Buccal	8	3.96
Submandibular & Submasseteric	7	3.47
Submandibular & Submental	7	3.47
Submandibular & Sublingual	5	2.48
Submasseteric	22	10.89
Submasseteric & Sublingual	1	0.5
Submental	8	3.96
Submental & Sublingual	10	4.95
Subperiosteal	55	27.23
Temporal	1	0.5

An odontogenic cause for the fascial space infection was determined in 157 cases (77,72%) whilst non-odontogenic causes accounted for 45 cases (22.28%).

Carious mandibular third molars were involved in 93 (46.04%) cases, followed by carious mandibular second molars with 28 (13.86%) cases and carious first mandibular molars with 18 (8.91%) cases. All the carious mandibular second molars developed distal caries as a result of the impacted third molars. Odontogenic infections related to third molar involvement revealed that in 46.06 % cases they played a primary role whilst in a further 13.86% cases there was an indirect association.

In non-odontogenic fascial space infections, fractured mandibles were the major contributor with 32 (15.84%) cases. Of the 32 cases of sepsis related to fractured mandibles, 25 (78.13%) recorded involvement of the mandibular third molars.

Mandibular third molars were associated in 146 cases (72.27%) that developed fascial space infections. The distribution and frequency of tooth involvement and aetiology of the fascial space infections is presented in Table 7.

Table 7: Aetiology and frequency of fascial space infection

Aetiology	Frequency	Percentage
Tooth 12	1	0.5
Tooth 16	4	1.98
Tooth 18	1	0.5
Tooth 21	2	0.99
Tooth 26	5	2.48
Tooth 28	3	1.49
Tooth 31	1	0.5
Tooth 36	14	6.93
Tooth 37	14	6.93
Tooth 38	52	25.74
Tooth 44	1	0.5
Tooth 46	4	1.98
Tooth 47	14	6.93
Tooth 48	41	20.3
DA fracture 33 - 43	1	0.5
Fractured mandible	32	15.84
3rd molars in # site	25	78.13
Infected hardware	4	1.98
Infected hematoma	3	1.49
Laceration	3	1.49
Pimple	1	0.5
Stab wounds	1	0.5

Six antibiotics were effective in the treatment of the patients either in isolation or in combination with another antibiotic. From the 202 cases, 278 different antibiotic prescriptions were administered to the patients with Augmentin being used most frequently (100 prescriptions). Antibiotic utilization is presented in Table 8.

Table 8: Antibiotics used to treat infections

Antibiotics	Frequency n	Percentage
Augmentin	68	33.66
Augmentin & Metronidazole	32	15.84
Clindamycin	2	0.99
Clindamycin & Metronidazole	3	1.49
Cefazolin	1	0.5
Benzylpenicillin	55	27.23
Benzylpenicillin & Metronidazole	41	20.3

When patients did not recover from initial therapy, either patients were taken back to the operating theatre for a relook procedure with or without a change in antibiotic (Table 9). The change in antibiotic was followed by microscopy and sensitivity from the initial pus specimen that was taken during primary surgery. Ceftriaxone was used when a change in antibiotic was indicated.

Table 9: Complications encountered

Complications	Total
Death	1
Mediastinitis	2
Re - look	6
Re - Look & Ceftriaxone	2
Ceftriaxone	1

Of the 202 patients that were admitted with fascial space infections, 201 patients were discharged home following a hospital stay and 1 patient demised.

The longest hospital stay was 29 days and the shortest was 1 day. Most patients were discharged within 5 days and the mean number of days patients spent hospitalised before discharge was 4.93 days (Table 10).

Table 10: Number of days hospitalised before discharge

Days in hospital	Frequency	Percentage %
0 - 3	48	23.8
>3 - 5	102	50.5
>5 - 7	21	10.4
>7	31	15.3

CHAPTER 5: DISCUSSION

Fascial space infections are routinely encountered by Maxillofacial and oral surgeons with underlying causes either odontogenic or non-odontogenic in origin. Odontogenic infections relate to infections that develop from teeth or underlying tissues that affect the periapical bone from where it then spreads to local or distant sites. Non odontogenic infections relate to those infections that develop associated mainly with fractures, infected salivary glands, tumours, cystic lesions and subcutaneous infections.

The total number of cases admitted to the CMJAH for surgery under general anaesthesia for this period was 840 of which 202 were admitted for management of fascial space infections. All were treated surgically in an emergency theatre. Fascial space infections comprised 19.39% of all cases treated under general anaesthesia for this period.

Studies investigating fascial space infections that included a significant number of cases are scarce. The study of Sanchez et al.,2011 reported a patient population of 151 from January 2007 - December 2008 in La Paz University Hospital, Madrid, Spain. In Adelaide, Australia 88 patients were recorded by Uluibau et al.,2005 for the period 1 January 2003 - 31 December 2003. Flynn et al., 2006 included 37 patients in their article during the period March 1996 - June 1999 in Boston, America. This study at CMJAH over a two-year period therefore involves the greatest number of patients presented in the literature to date.

Distribution of fascial space infections by sex revealed that men had a prevalence of 68.32%. This finding confirmed the reports of Dodson et al., 1989, and Saito et al, 2011, with similar ratios. Dodson suggested that men have a greater tendency to develop fascial space infections as a result of inferior oral hygiene care and they also tended to neglect pursuing remedial treatment when experiencing minor orofacial infections.

The fascial spaces involved presented either in isolation or in combination with other spaces. The submandibular space was the most commonly affected fascial space, confirming the findings of Rega et al., 2006, Rao et al.,2010 and Sanchez et al., 2011. They hypothesized that this was due to the apices of the molar roots being situated below the mylohyoid muscle.

Odontogenic causes were identified as the primary aetiological factor for the development of the infection in 77.72% of cases in the study. This was higher than the findings of Amaidas, 1990, who in a study at the University of the Western Cape over a 3 year period, reported that odontogenic causes accounted for 56.7% of the fascial space infections treated whilst 21.7% of the remaining causes was due to teeth left in the line of fracture post-surgery. Early reports in the literature by Woods, 1978, Morey et al., 1984 and Guralnick, 1984 found that odontogenic bacterial infections were the major causes of fascial space infections.

In our study carious third molars were identified as the major cause of odontogenic cases with a 46.04 % followed by carious 2nd molars at 13.86 %. In the cases designated as non-odontogenic, infected fractured mandibles were the major cause of fascial space infections and in 78.13% of these cases the fractures involved third mandibular molars. Third molar teeth were found to be associated in 146 (72.27%) of the 202 cases of fascial space infection. All odontogenic infections were caused by carious teeth. Hereby we conclude that our hypothesis has been proven that that impacted third molars are a major aetiological agent in the development of fascial space infections.

Flynn et al., 2006 concluded that decayed third molars were the main aetiologic factor in fascial space infections of odontogenic origin (65%). Pericoronitis (22%) and periodontal infections (22%) were next most common. Umeda et al., 2003 reported that 70 - 80% of odontogenic infections are caused by second and third mandibular molars.

Either Augmentin or Benzylpenicillin were used as the antibiotic of choice for single space infections, however Augmentin was the preferred antibiotic. Metronidazole was added to the antibiotic regime when 2 or more fascial spaces were involved. Penicillin remain the empiric first choice of antibiotic for odontogenic infections due to their effectiveness, low cost, patient tolerance, minimal side effects and availability. In this study only 3 patients necessitated a change of antibiotics, confirming the efficacy of the antibiotic.

All the patients treated in this study were managed according to the principles and guidelines suggested by Peterson. The average period of hospitalization was calculated at 4.93 days ranging from 1 – 29 days. This is similar to the findings of Flynn et al., 2006, who reported a mean hospital stay of 5.1 days.

The fourth decade of life was found to be the most commonly affected with fascial space infections. The mean age was 34.14 years ranging from 16 – 84 years, which are comparative to other studies around the world. Sanchez et al., 2011 reported a mean age of 40.3 years while other studies reported a much lower mean age i.e.: Flynn et al., 2006 with a mean age of 34.9 years and Uluibau et al., 2005 reported a mean of 34.5 years.

The severity of fascial space infections with their associated patient morbidity and cost raises the question of the prophylactic removal of impacted, non-functional or diseased third molar teeth. Third molars are different from other teeth and are associated with a higher degree of disease when compared to other teeth in the mouth. They are often non-functional, erupt last into the oral cavity and situated most distal in the dental arch. The location and eruption pattern are responsible for inadequate space for eruption and to maintain good oral health.

The malpositioning of third molars far posterior in the mouth leads to poor soft tissue support around teeth, creating pocket areas that are ideal for harbouring bacteria, which leads to subclinical inflammation which may progress to pericoronitis and infection. The inflammatory host response ultimately results in destruction of the periodontium that surrounds the root of the tooth. This leads to loss of connective tissue and bony support and promote periodontal pocketing and dental caries which are difficult to manage.

The surgical removal of 3rd molars is done routinely by Maxillofacial and Oral surgeons. The American Association of Oral and Maxillofacial surgeons have developed a White paper on the management of third molars with the use of evidence-based medicine. The AAOMS believes that experts in the field of interest should take the responsibility for making sound and active decisions on the management of third molars. It is important that removal of third molars should be carried out by a suitably qualified practitioner that has undergone extensive training in order to minimise risks and complications. Maxillofacial and oral surgeons are experienced and are actively involved with the treatment of third molars and therefore ideally positioned to make sound decisions considering both short- and long-term consequences of removal or retention strategies that will benefit the patient.

Third molars are associated with important anatomical structures and as these teeth age the roots are more likely to approximate the neurovascular canal, adjacent teeth and maxillary sinus. When infection occurs, the spread is determined by the apex of the roots together with muscle attachments and cortical thickness of the bone and this may compromise the health and integrity of these related structures.

Despite the risk of infection alone, several other well documented pathologies are associated with retained third molars which include several cysts, tumours and the risk for involvement in mandibular fractures.

The consequences of retaining third molars are therefore multiple and due to the sparsity of prospective studies the problems associated with retention are not well understood. Two studies by McArdle and Renton, 2012 and Bouloux et al., 2015 highlight the implications of retaining third molars over time. McArdle and Renton, 2012, reviewed the effects of the United Kingdom's N.I.C.E. Guidelines over a decade. They concluded that the reason for removal of third molars has changed from impactions to caries, periodontal disease and pericoronitis. They also illustrated that while initially the incidence of third molar removal was decreased as a result of the N.I.C.E. guidelines, the removal of third molars is as common as pre-N.I.C.E. guidelines but in a much older population. They suggested that the number of third molar surgeries will always be substantial. The findings of our study which shows that the mean age of patients developing fascial space infections is 34.14 years are in keeping with the findings of McArdle and Renton

Bouloux et al., 2015 did a systematic review to determine what the risk of one or more third molars being extracted in the future amongst individuals that opt to retain their asymptomatic third molars. They concluded that the risk for removal of a once asymptomatic third molar increases with patients age, due to caries, periodontal health and other inflammatory conditions. It therefore warrants a good discussion with a patient when reviewing the risks and benefits of third molar retention as a management strategy. Patients who elect the retention option should be followed with active surveillance with periodic follow up visits.

Despite the fact that most patients will eventually require removal of their third molars, some will be able to maintain these teeth for a lifetime.

Complications associated with the removal of third molars are well documented in the literature and as with all surgeries there are always risks for complications to develop. The complications associated with third molar surgery are however minor and usually resolve within a few days.

Complications vary from inflammatory conditions such as infection or osteitis, haemorrhage, injury to adjacent anatomic structures, teeth or nerves, periodontal defects, fractures of the maxillary tuberosity or mandible, persistent oral-antral communication, retained roots and the need for additional treatment to manage complications. The Maxillofacial and oral surgeon is however well trained and able to handle all complications that may arise.

Fascial space infections appear to becoming more common. Recognized treatment strategies are able to minimize the risk of the infection developing into life threatening conditions such as Ludwig's angina. Males are more commonly affected in the fourth decade. The presence of third molar teeth and co-morbidities such as HIV infection appears to predispose to the development of a fascial space infection. Not all patients disclose their retroviral disease status and patients were not routinely tested for the virus, which might influence the number of patients reported as being healthy. Out of the study population, 78.2% reported to be healthy,12.87% admitted to being infected with HIV and 3.47% suffered from diabetes mellitus.

The prophylactic removal of mandibular third molars during their development may contribute to a reduction in the severity of odontogenic infections. This will decrease the usage of scarce resources to treat fascial space infections and to prevent significant morbidity to patients. The value of adequate patient education combined with regular dental visits and dental sepsis control is confirmed to minimize the potential development of fascial space infections.

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ANNEXURE

Annexure A: Data collection sheet:

1. Age
2. Gender
3. Comorbidity:
4. Social habits: Smoking

   Alcohol

   Substance abuse
5. Facial spaces involved
6. Number of days in hospital
7. Aetiology of the infection
8. Antibiotics administered
9. Complications

Annexure B: Turnitin report

Dr

ORIGINALITY REPORT

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