INCIDENCE OF ALVEOLAR OSTEITIS IN TWO JOHANNESBURG HOSPITALS,

SOUTH AFRICA.

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A Research Report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa in partial fulfillment of the requirements for the degree of Master of Science in Dentistry in the branch of Maxillofacial and Oral Surgery.

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DECLARATION

I, Idemudia Eguavoen hereby declare that this research report is my own work. It is being submitted for the degree of Master of Science in Dentistry in the branch of Maxillofacial and Oral Surgery in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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Dr. I Eguavoen

DEDICATION:

This work is dedicated to Almighty God the source of all knowledge,

And to my wife and children

ACKNOWLEDGEMENT:

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List of Abbreviations

1. **AO**   Alveolar Osteitis

2. **OH**   Oral hygiene

3. **WOHC**   Wits Oral Health Centre

4. **CHBAH**   Chris Hani Baragwanath Academic Hospital

5. **MFOS**   Maxillofacial and Oral Surgery

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Abstract:

Purpose: The aim of the study is to determine the incidence of Alveolar Osteitis (AO) in two Johannesburg Hospitals, South Africa. The objective was to determine the prevalence of known risk factors in this study population. It was hoped that this study will help to reduce or eliminate the development of AO.

Methods and Materials: This was a prospective study conducted over a 6 months period from April 2015 to September 2015 at Chris Hani Baragwanath Hospital (CHBH) and Wits Oral Health Centre (WOHC). The data was collected from hospital records of the patients and structured questionnaires. The information on the questionnaires included; age, sex, race, past medical history, past dental history, social history, the amount of local anaesthesia used, the extraction site, the type of extraction (intra- alveolar or trans-alveolar), the usage or non-usage of irrigation during the procedure, method of sterilization of surgical instruments, level of experience of the operators, pre-and post-operative instruction(s), and any record of post-operative prescription given.

Results: In this study 2,970 dental extractions were performed in 2,218 patients. The incidence of AO was 102/ (102+2116) = 4.6% (at 95% confidence interval: 3.8-5.6%). The minimum age was 19 years, maximum age was 80 years and the mean age was 37.7. There was a slight female preponderance (6.1%) than in males (3.1%). The ratio of females to males in the AO patients was 1: 0.83. The mandibular 3rd molar extraction had 15.7% prevalence of AO, was the most common site to be affected. The prevalence of AO in trans-alveolar extractions was 16.0% while in intra-alveolar extractions was 4.0%. Single extractions had 5.3% prevalence of AO, while multiple extractions had 2.7 %. Poor oral hygiene was found in 58.9% of the AO patients. Pain

was the most common presenting symptoms in the AO patients (99.0%). Underlying medical condition was found in 30.6% of the AO patients while 39.2% smoked and 49.0% consumed alcohol in the AO patients.

Conclusion: This study found a statistically significant association between AO and the following variables: gender (more for female), oral hygiene status, single extractions, the amount of local anaesthetic administered, the use of irrigation during extraction, third molar surgeries (surgical trauma), and the level of operator experience.

Chapter 1: <u>**Introduction and Literature Review**</u>

1. 1 Introduction and Literature Review:

Alveolar Osteitis (AO) is a known complication after tooth extraction, or the surgical removal of a tooth. AO is commonly known as "dry socket". AO is also known as *local osteitis*, *alveolitis sicca dolorosa*, *localized alveolar osteitis, fibrinolytic alveolitis, septic socket, necrotic socket,* and also as *alveolalgia.*[1] AO was first described by Crawford in 1896. The incidence of AO ranges from 1% to 4% of extractions.[1] This incidence reaches 45% for mandibular third molars,[1,2] with a highest incidence occurring in the 40-45 year age group.[3] Birn[4] showed increased fibrinolytic activity and activation of plasminogen to plasmin in the presence of tissue activators in AO.[1,4] This fibrinolytic activity is thought to affect the integrity of the post extraction blood clot.[1,2,5,6]

Although the aetiology of AO is not known and its pathogenesis is not clear, the following have been accepted as risk factors: poor oral hygiene,[3,7,8] smoking,[5,9,10] traumatic surgery,[5,9] female patients on oral contraceptives,[2,3,10] lack of operator's experience,[2,3,9] patient's gender,[2,8,10] patient's age/increased age,[3,9] mandibular third molar extractions,[2,6] bacterial infection,[2,3] local anesthetic with vasoconstrictors,[2,3] single versus multiple extraction,[3] saliva/bone/root fragments remaining in the wound,[11] flap design/use of sutures,[2] inadequate irrigation[3,5,12] and some systemic diseases such as diabetes mellitus.[3,10]

The classical signs and symptoms of AO include post-operative pain surrounding the alveolus that responds poorly to over the counter narcotic analgesics. The post-operative pain surrounding the interior of the alveolus usually starts between 1-3 days after extractions and increases in severity followed by partial or total clot loss in the interior of the alveolar, with or without

halitosis. Trismus, local hyperthermia and regional lymphadenopathy can also occur. [1, 13, 14].
Degradation of the blood clot in association with dissolution of erythrocytes and fibrinolysis, and
the absence of organized granulation tissue have also been described in histopathology
investigation of dry socket.[1]

AO is self-limiting in that the condition runs a definite and limited course. A range of
management modalities includes those that are directed locally toward the socket while others are
directed systemically. Those directed to the socket include:

Firstly, irrigation of the socket with a 0.12-0.2% chlorhexidine.Chlorhexidine is an antibacterial
agent that is used as an antiseptic. At a low concentration it is bacteriostatic (0.03% to 0.06%),
while at high concentration it is bacteriocidal ($< 0.12\%$- 0.2%).   It is active against gram-positive
and gram-negative organisms, facultative anaerobes, aerobes, fungus and probably yeasts
infections. It also acts against some viruses including Hepatitis B virus and Human
Immunodeficiency Virus. Chlorhexidine has been shown to be more effective than warm saline.
[2,8] There is evidence to support the use of a 0.12% chlorhexidine rinse prior to the extraction and
one week post-extraction to prevent the occurrence of dry-socket following tooth
extraction.[2,3,5,8,14-16]   The use of 0.2% chlorhexidine in the form of a bioadhesive gel is believed
to be more effective than the mouthwash.[15] This is because the intra-alveolar positioning of the
gel would provide continuous availability of chlorhexidine inside the socket and thus prolong the
release of the active substance and give a more direct action on the alveolus. Besides, the gel can
be used immediately, unlike the chlorhexidine rinse, which should not be applied within the first
24 hours post-surgery to avoid clot detachment.[15] In addition, intra-alveolar application of the gel
relieves the patient from the adverse effects of the chlorhexidine rinse i.e. staining or disturbance

of taste sensation.[15] An added advantage is that chlorhexidine is cheap and economical. It is reported to be effective prophylactically and has no documented side-effects.[17]

Secondly, placement of a self-limiting dressings such as the following; (a)*Alvogy*l® (Septodont) which contains eugenol, butamen and iodoform (b) An obtundant dressing such as zinc oxide ,eugenol and lidocaine gel or combination of these therapies. Zinc oxide Eugenol is a non-reabsorbable dressing is a foreign body in the socket and will delay wound healing[8]. Jesudasan et al.[13] in a systematic review, showed a post-operative decrease in pain and complication with the use of eugenol and concluded that eugenol is a viable and safe option for the management of AO. However, it is not necessarily the best option when compared to other options available.[13]

Thirdly, prescription of antibiotics and non-steroidal anti-inflammatory drugs (NSAID) based on the condition that there is no contra-indications in the patient's medical history.[7,11,17-23] The use of both systemic and topical antibiotics has been proven to reduce the incidence of dry socket.[17-23] Penicillin, Clindamycin, Erythromycin, Metronidazole, and topical Tetracycline powder have all been shown to be effective.[8, 17] Preoperative administration of antibiotics is more effective in decreasing the incidence of AO than when given postoperatively.[8, 12] Blum reported that Metronidazole is the only antibiotic that withstands clinical trial successfully in a randomized double-blind study.[14] Sekhar et al.[18] reported a prospective clinical trial of preoperative and postoperative Metronidazole and found no significant advantages of antibiotic prophylaxis in terms of post-operative pain, swelling, mouth opening and wound healing. Ritzau et al.[19] also found no significance effect of single dose of Metronidazole in the prevention of AO. Bergdahl et al.[20] conducted a study in which 1600mg of Metronidazole in a single dose were given to 60 patients, the result of the study showed no prophylactic effect in relation to AO. It is widely accepted that systemic antibiotics should not be prescribed for the treatment of a true alveolar

osteitis as they have no additional advantage over local treatment directed to the socket in patients whose immune system has not been compromised. [1,7,21] The reason for reduction in incidence of AO following preoperative administration of antibiotics is unclear as infection is not believed to be of significance in the pathogenesis of AO, although a reduction in bacteria count does decrease the incidence.[8] Sener et al.[22] stated that antimicrobial agents have been advocated for the prevention of AO on the basis of the postulation that the pathogenesis of AO is mostly infective. He stated further that some workers have successfully used intra-alveolar (topical) tetracycline base agents, but results from clinical trials with systemic prophylactic antibiotic regimens including the administration of Penicillin and Metronidazole have been unable to show any preventive effect of prophylaxis.[22]

Numerous studies with topical Tetracycline powder, aqueous suspensions of Tetracycline, Tetracycline on gauze drain or Tetracycline-soaked gelfoam sponges have been reported to be effective in significantly decreasing the incidence of AO, [14] while Sanchis et al.[23] reported that they did not believe that intra-alveolar (tropical) Tetracycline placement is indicated to prevent dry socket, nor the pain and inflammation of the postoperative course of AO. The use of petroleum-based carriers is discouraged to avoid myospherulosis (a foreign body-type granulomatous reaction to lipid-containing material and blood) a complication of delayed wound healing by action of lipid substance of the carrier vehicle on extravasated erythrocytes.[3, 4, 7] Nonetheless, no negative reactions to the topical Tetracycline have been described, and also they are considered to be an economical preventive modality[14].

Fourthly, topical Corticosteroids and Antifibrinolytics (parahyrobenzoic acid-PABA and Tranexamic acid-TEA) have been used in the prevention of AO but unsuccessful in the reduction of the occurrence of AO. [2,4,15] Corticosteroids have been reported to reduce the immediate post-

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operative complications, but it has failed to reduce the incidence of AO.[2,3,15] However, there is no scientific study that has been able to prove the effectiveness of these agents. Abu Younis et al.[24] reported that some antifibrinolytic agents when placed topically in the extraction site have been proven to decrease the incidence of AO.

The management of AO is as controversial as the condition itself. Some of the literatures recommend the use of 0.12% chlorhexidine pre-operatively, 0.2% bioadhesive gel post-operatively.[11,15] These have been scientifically proven to effective in reducing and preventing the incidence of AO.[11,15] Similarly, the post-operative use of obtundant dressings (Zinc Oxide Eugenol and Alvogyl®) have been proven to be effective in the management of AO and both readily available and cheap, but the associated side effects of delayed wound healing and bone necrosis cannot be completely ignored.[13]

Platelet Rich Fibrin (PRF) is the second generation of platelet concentrates after Platelet Rich Plasma (PRP) where autologous platelets and leucocytes are present in a complex fibrin matrix to accelerate the healing of hard and soft tissues. PRF contains various autologous cytokines and immune cells; it is a fibrin membrane that covers the wound and can be sutured.[25]

Eshghpour et al.[25] conducted a double-blinded study in which patients with bilateral mandibular impacted third molars underwent surgical extractions, with one socket received PRF and the other socket served as a control. They reported that the application of PRF in the extraction sockets of impacted mandibular third molar decreased the frequency of AO significantly.[25] Rutkwowski et al.[26] conducted a study which found a substantial decrease in the incidence of AO following the treatment of the extraction site with PRF. The lower frequency of AO after PRF application could be related to the haemostasis and cicatricial properties of PRF[25].

PRF produces a three- dimensional architecture that provides a reservoir of platelets, leucocytes and various cytokines/fibrinogen degradation products (FDPs) which stimulate the migration of neutrophils. Fibrinogen Degradation Products (FDPs) increase the expression of CD 11c and CD 18 receptors that play a role in neutrophils migration.[25] It also provides a natural fibrin matrix that supports clot formation and covers the clot to prevent mechanical dislodgment. PRF sealing ability prevents the ingress of bacteria into the socket.[25] This simple and cost-effective technique appears to be a viable methodology by which dental practitioners can decrease the incidence of AO formation in patients.[26]

AO is the most common known complication of exodontia. It is a complication that has continued to torment patients; this has become a source of concern for many dental surgeons for many centuries. Apart from the conventional preventive and treatment protocol which involves the use of 0.12% chlorhexidine mouthwash followed by the placement of obtundant dressings such as Zinc oxide Eugenol and Alvogyl coupled with the administration of systemic analgesics and antibiotics, Platelet Rich Fibrin (PRF) has also been found to reduce the frequency of AO when applied into the socket immediately after extraction.[25,26]

Chapter 2:   Methods and Materials

2. 1 Aim: The aim of the study is to determine the incidence of Alveolar Osteitis in two Johannesburg hospitals, South Africa.

2.2 Objective: To determine the prevalence of known risk factors in this study population.

2.3 Significance of the Study: This study will help to identify patients with risk factors and thus in the long prevent the development of AO.

2.4 Study Design: The study was a prospective study. Hospital records which include age, sex, race and treatment done were kept for all the patients who had permanent tooth extraction from the ages of 18 years to 80 years, both males and females in the dental surgeries of Chris Hani Baragwanath Academic Hospital (CHBAC) and Wits Oral Health Centre (WOHC) over a 6 month period, from April 2015 to September 2015. Furthermore, a specially structured data collection form/questionnaire was completed for all patients who presented back to the same clinic/hospital within the study time frame with clinical sign and symptoms which were diagnosed as AO. The data collection form/questionnaire included the following patients' demographics: (sex, age and race), past medical and dental history, social history of the including tobacco usage and alcohol consumption, the status of the operating surgeon, post-operative instruction given (verbal or written or both) and the onset of the clinical signs and symptoms of AO.

The assessment of patients was ranked by the dental students/surgeon's visual examination of the amount of plaque and calculus present on the patients' dentition and amount clearly visible to the dental students/surgeons' naked eye. Oral hygiene was graded as either: 'good with no plaque and calculus formation' or 'poor with visible plaque and calculus formation'.

2.5 Study Population: The diagnosis was made according to Blum's definition of dry socket if patients had the following signs and symptoms:-[13]

a. Post-operative pain and tenderness in and around the extraction site, which increases in severity at any time from day 1 to day 3 after extraction.

b. Partially or totally fragmented (empty) blood clot inside the alveolar socket with or without halitosis.

2.6 Exclusion criteria: All patients younger than 18 years and any patient that was not willing to participate were excluded from the study.

2.7 Inclusion criteria: All patients 18 years and older presenting for tooth extraction and who were willing to participate were included in the study.

2. 8 Research Questions

- To determine prevalence of AO in the study group.

- To do a descriptive analysis of the study variables (risk factors) in the AO group.

- To compare the prevalence of AO variables (risk factors) from data that was collected for both AO and non-AO groups.

2.9 Sample size

The key focus of this research is to the determination of the incidence of AO in the sample. Using an expected incidence of 4% and a precision of 2%, indicate that a sample size of 369 is required.

However, 4% of 369=14, which would not be enough AO cases for further descriptive analysis. It was thus decided that data collection would continue until at least 100 AO cases has occurred. I chose to have at least 100 AO cases so that descriptive statistics on the cases, based on the reporting of a 50% proportion(if any given characteristics), which is the worst-case in terms of sample size, with a 95% confidence interval, could be done just under 10%(9.8%) precision. Sample size for proportions was determined using the formula:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where n = sample size,

Z = Z-statistic for the chosen level of confidence,

P = expected prevalence or proportion

d = precision.[27]

2.10 Data Analysis

The prevalence of AO in the study group was determined, as well as confidence interval at 95%

The characteristics of the patients with AO were analysed descriptively, as means and standard deviations (with histograms) for continuous variables, and frequencies and percentages for categorical variables.

The available variables (i.e. where there was data for both the AO and non-AO groups) as risk factors for AO was carried out using a logistic-binomial regression, which allows for a direct estimation of the Risk Ratio (RR) to be established. Data analysis was carried out using SAS version 9.4 for Windows. The 5% significance level was used.

2.11 Ethics Committee Approval

Ethical clearance (M150235) for this prospective study was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand. Permission to conduct the study was also obtained from both the Chief Executive Officers of WOHC and CHBAH. Informed consent was obtained from each patient for their inclusion in the study. Verbal and written explanation of the study was given prior to obtaining consent from patients who fulfil the inclusion criteria. Strict confidentiality was adhered to at all times. There was no foreseen harm to patients who were willing to participate in this study.

2.12 Limitations

There were two major limitations in this study. The very first limitation was the very poor record keeping in most public hospitals. As a result, some valuable patient data was either not recorded or simply lost.

The second major limitation was that only patients diagnosed with AO that were included in the result of the study and that not all patients (AO and non-AO) were reviewed post-operatively. Although all the patients who had their teeth extracted, their records recorded, met the inclusion and exclusion criteria and signed the consent forms were asked to return if they experienced any signs and symptoms of AO, some patients with signs and symptoms of AO might not have returned to the research facilities, CHBAH and WOHC, for various reasons beyond the researcher's control.

Chapter 3: Results

3.1 Introduction

In this study 2,970 dental extractions were performed in 2,218 patients. One hundred and two patients (of the 2,218 patients) developed AO. The incidence of AO was thus 102/ (102+2,116) = 4.6% (95% confidence interval: 3.8-5.6%).

3.2 Descriptive analysis of the characteristics of the AO patients and non-AO patients

3. 2.1 Age: the median age of the AO patients was 35 years (interquartile range 27-46 years; range 19-80 years). The distribution of ages is shown below (Figure 3. 1). There was no data collected for non-AO patients.
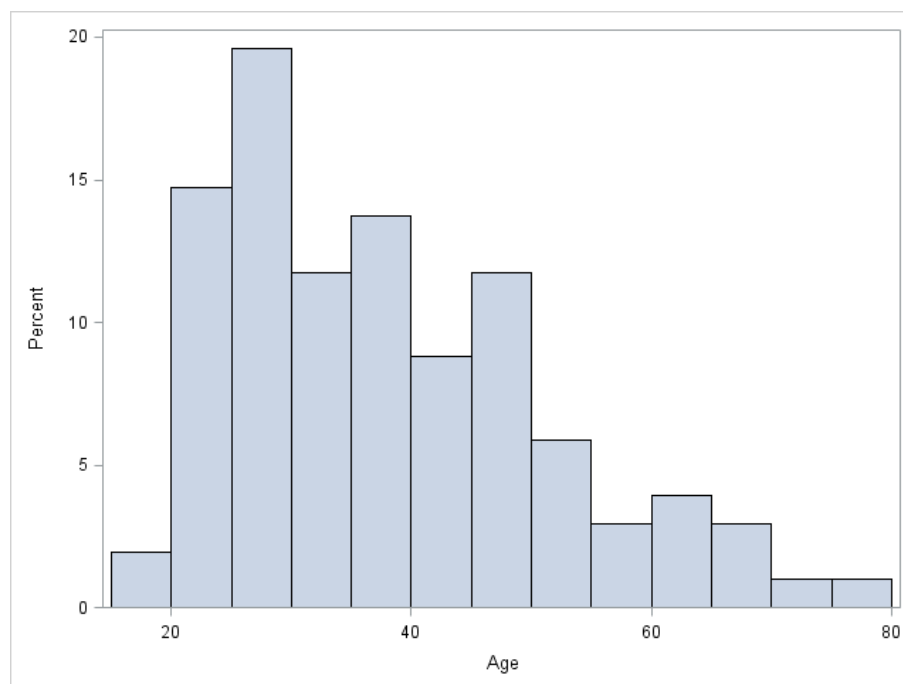
Figure 3. 1: Distribution of the ages of the patients with AO.

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3.2.2 Gender: Sixty- four, 64.7% of the AO patients were female. The prevalence of AO was significantly higher in females (6.1%) than in males (3.1%) (RR 1.95; 95%CI: 1.31-2.91). The female to male ratio of 1: 0.83 in the AO group. Thus, females were 1.95 times more likely to develop AO, compared to males. Both males and females have the age range of 21-30 years with the incidence of AO (Figure 3.2).
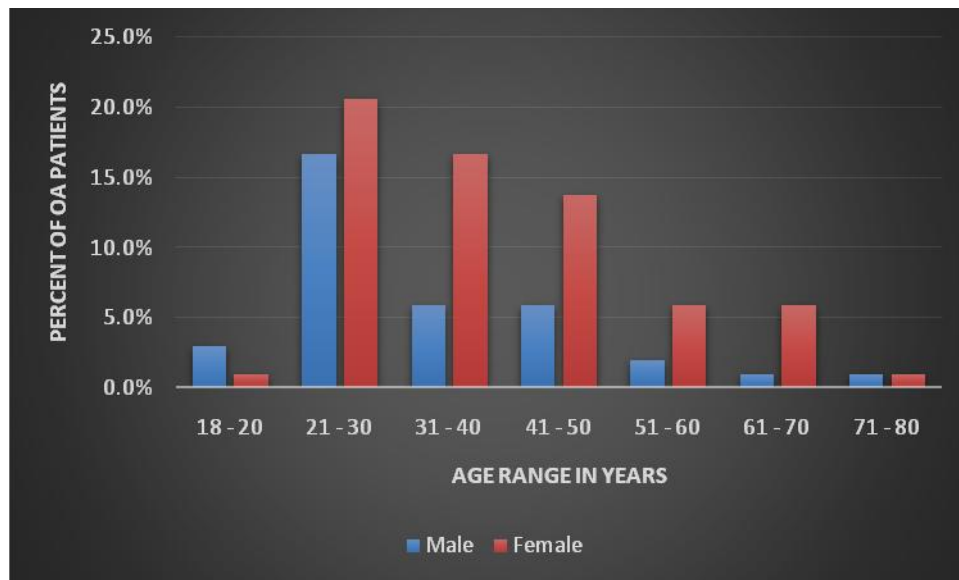
Figure 3. 2: Distributions according to age and gender of patients with AO.

3.2.3 Ethnicity: Seventy-four (74.5%) of the AO patients were Africans, 14(13.7%) of the AO patients were Caucasians, 8(7.8%) of the AO patients were Coloured, while 4(3.9%) of the non-AO are Asians. One thousand, six hundred and nineteen 1,619 (76.5%) of the non-AO patients were Africans. Sixty-two (2.95) of the non-AO patients are Caucasians, 336 (15.9%) of the non-AO patients were Coloured, while 99 (4.7%) of the non-AO patients were Asians. The prevalence

of AO in this study for African was 4.5%, for Caucasian was 18.4 % (RR 0.89, 95% Cl 0.51-1.56), Coloured 2.3 %(RR 1.67, 95% CI: 0.83-3.36) and Asian was 3.9 %(RR 1.35, 95 CI 0.51-3.58). There was no significant difference in the prevalence of AO in the Caucasian, Coloured or Asian groups, compared to the African group (Figure 3. 3).
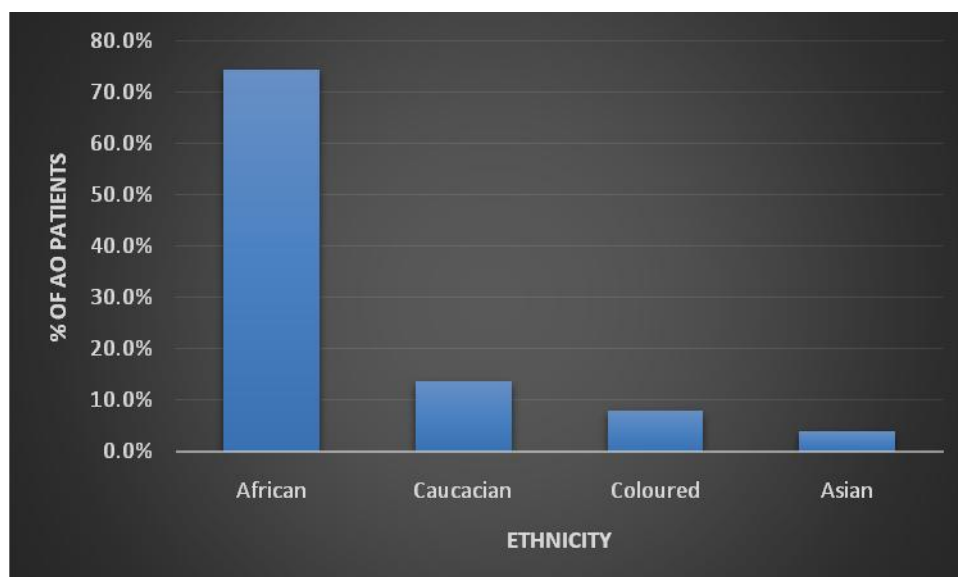
Figure 3.3: Ethnic distributions

3.2.4 Oral hygiene: Forty, 40.2% of the AO patients had good oral hygiene, while the rest had poor oral hygiene. The prevalence of AO was significantly higher in those with poor oral hygiene (9.9%) than in those with good oral hygiene (2.7%) (RR 3.65; 95%CI: 2.49-5.37). Thus, those with poor oral hygiene were 3.65 times more likely to develop AO, compared to those with good oral hygiene.

3.2.5 Medical history: Within the AO patients, the most common medical history was the use of oral contraceptives (28.8% in the females). Fifteen (14.7%) patients had diabetes mellitus, 4 (3.9%) had *HIV/AIDS*, 2 (2.0%) were on Corticosteroids. Note that the percentages in the graph Figure 3.4 do not add up to100% since patients could have had more than one factor. There was no data for non-AO patients.
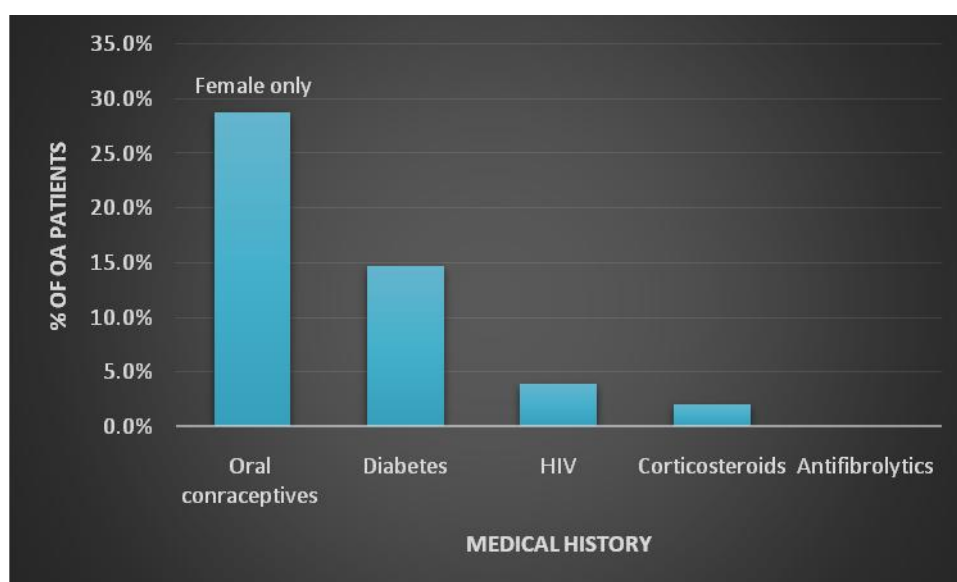
Figure 3. 4: Distribution according to the medical history

3.2.6 Social history: Forty-nine percent of the AO patients used alcohol, 39.2% smoked and 1.0% abused drug substances. Note that the percentages in the graph Figure 3.5 do not add up to 100% since some patients smoked and used alcohol as well. There was no data collected for non-AO patients.
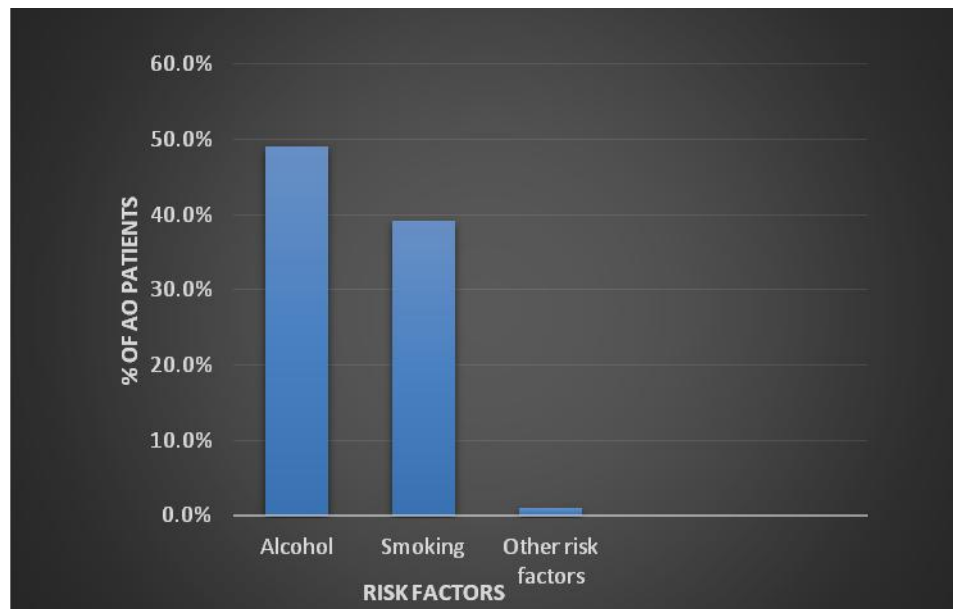
Figure 3. 5: Distributions according to Social Risk factors

3.2.7 Level of experience of operator:

The extractions of the patients who developed AO were performed most often by dentists 58 (56.9%), followed by dental students 34 (33.3%), MFOS Registrars 10 (9.8%) MFOS Specialists (0.0%). The prevalence of AO was higher for patients operated on by dental students (6.4 %) than by dentists (4.0%) (RR 1.60; 95%CI: 1.06-2.42). This result was statistically significant. Thus, patients operated on by dental students were 1.60 times more likely to develop AO, compared to those who had been operated on by dentists. There was no significant difference in the prevalence of AO between patients operated on by the dentists versus registrars (Figure 3. 6).
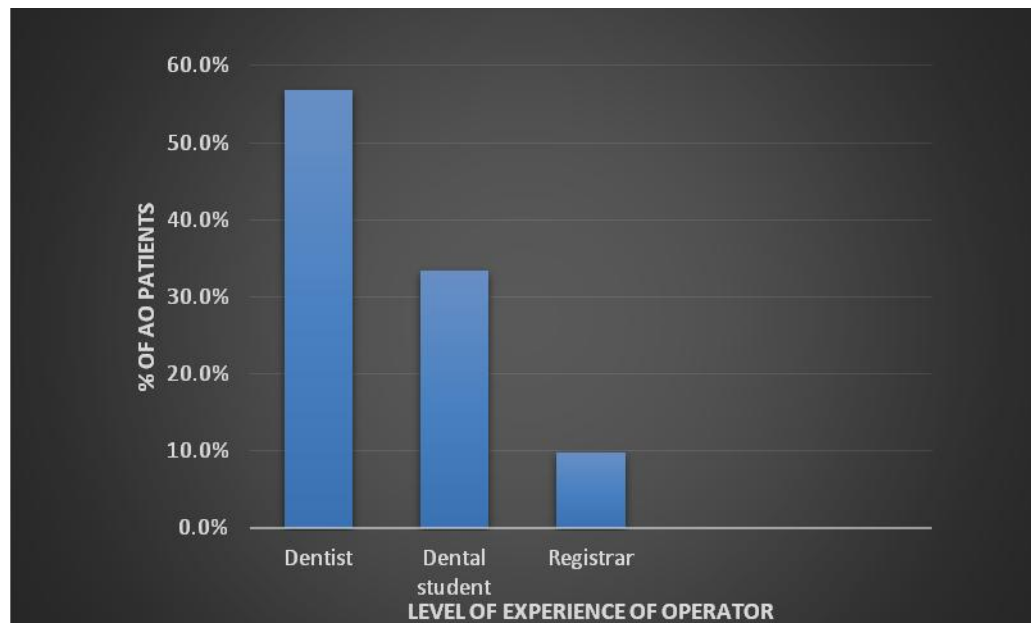
Figure 3. 6: Distribution according to the Level of the operator experience

3.2.8 Local anaesthetic (LA):   In all cases, the AO patients had received LA containing a vasoconstrictor. The number of cartridges ranged from one to six. 56.9% of the AO patients had received two cartridges.

The prevalence of AO was significantly higher for patients with 2, 3, or 4 or more cartridges (6.2, 4.6 and 13.8% respectively) than for patients with only 1 cartridge (2.1%) (RR 2.88; 95%CI: 1.75-4.76 for 2 cartridges; RR 2.13; 95%CI: 1.09-4.16 for 3 cartridges; RR 6.43; 95%CI: 2.35-17.6 for 4 or more cartridges). Thus, patients with 2 cartridges were 2.88 times more likely to develop AO, compared to those with only one cartridge (Figure 3. 7).
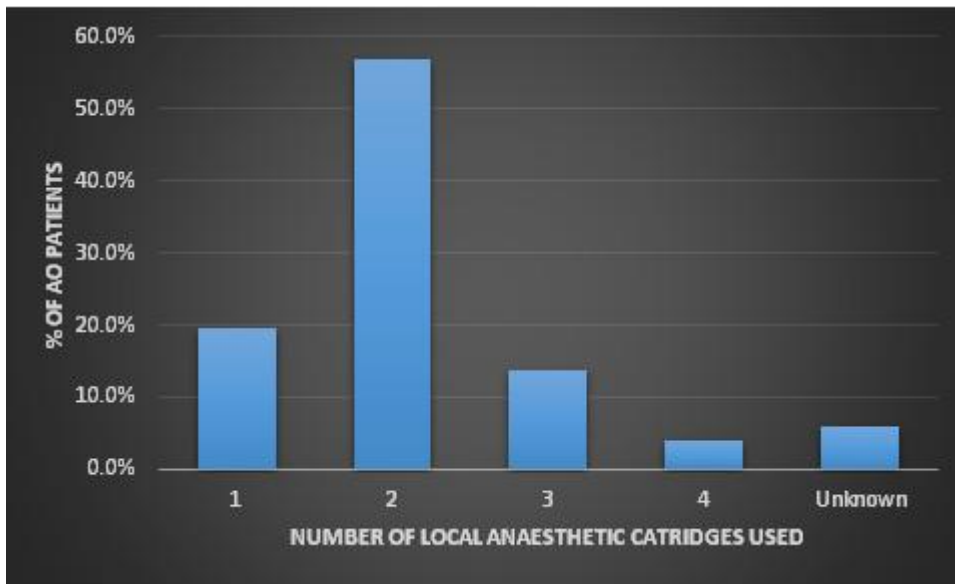
Figure 3. 7: Distribution according to the amount of the local anaesthesia administered.

3.2.9 Details of type of extraction done:

a. **Single vs. Multiple**: Eighty-Seven, (85.3%) of the AO patients had a single extraction, while

15(14.7%) of the patients had multiple extractions. One thousand, five hundred and sixty-nine

(74.1%) of the non-AO patients had single extractions, while 546 (25.8%) had multiple

extractions. The prevalence of AO for multiple extractions was 2.7%, while for single extraction

was 5.3% (RR 1.96; 95% CI: 1.15-3.37). Thus, those with single extractions were 1.96 times

more likely to develop AO, compared to those with multiple extractions.

b. Intra-alveolar vs. Trans-alveolar: Eighty- two (82.4%) of the AO patients had an intra-

alveolar procedure, while the rest had a trans-alveolar procedure. The prevalence of AO was

significantly higher in trans-alveolar procedures (16.0%) than in intra-alveolar procedures (4.0%)

(RR 4.02; 95%CI: 2.53-6.39). Thus, those with trans-alveolar procedures were 4.02 times more

likely to develop AO, compared to those with intra-alveolar procedure.

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Maxillary Teeth

	Incisors and Canines		Premolars				1st Molar		2nd Molar		3rd Molar		Total
Extraction sites	21	23	14	15	24	25	16	26	17	27	18	28	
No of cases of dry socket	1	1	2	4	3	5	6	3		3	2	2	32
Dry Socket %	1	1	2	3.9	2.9	4.9	5.9	2.9		2.9	2	2	31.4

Mandibular Teeth

	Incisors and Canines		Premolars				1st Molar		2nd Molar		3rd Molar		Total
Extraction sites			44	45	34	35	36	46	37	47	38	48	
No of cases of dry socket			3	2	1		15	9	4	9	16	11	70
Dry Socket %	☐	☐	2.9	2	1	-	14.7	8.8	3.9	8.8	15.7	10.8	68.6

Table 3.1: Distribution of AO by Jaw Locations. This table show the distribution of AO by the jaw locations (maxilla or mandibular) and the particular tooth with the highest percentage of AO.

3.2. 10 Sterilisation: In all cases (AO and non- AO) autoclave sterilisation, Medi- Clave- JSD 200litre B-class was used. The duration of sterilization ranged from 1hour to 1 hour and 30 minutes.

3.2.11 Irrigation vs. Non-irrigation: Thirty-seven (36.3%) of the AO patients had irrigations of the socket with normal saline done during the procedure, 65 (63.7%) did not have irrigations of the socket done during the procedure. Two hundred and thirty-one (10.9%) of the non-AO patients who had irrigations of the sockets, while 1882 (88.9%) of the patients did not have irrigations. Three (0.1%) patients had unknown result. The prevalence of AO for patient who had irrigation was 13.8 % (RR 4.13, 95Cl 2.82-6.06), while for the patient who had no irrigation was 3.3%. Thus, those who received irrigation were 4.13 times more likely to develop AO, compared to those who did not.

3.2.12 Post-operative medication: Forty- seven (47.1%) of the AO patients received post-operative medication, while the rest did not. Ninety –five, 95.1% received post-operative instructions, while the rest did not. There was no data for non-AO patients.

3.2.13 Post-operative Instruction: Ninety-seven (95.1%) of the AO patients received post-operative instructions, while 5 (4.9%) did not receive any post-operative instruction.

3.2.14 Signs and Symptoms of AO

Signs and symptoms of AO: The most common symptoms were pain (99.0%) and empty socket (78.4%). Note that the percentages in the graph below do not add up to 100% since patients could have had more than one sign/symptom (Figure 3. 8).
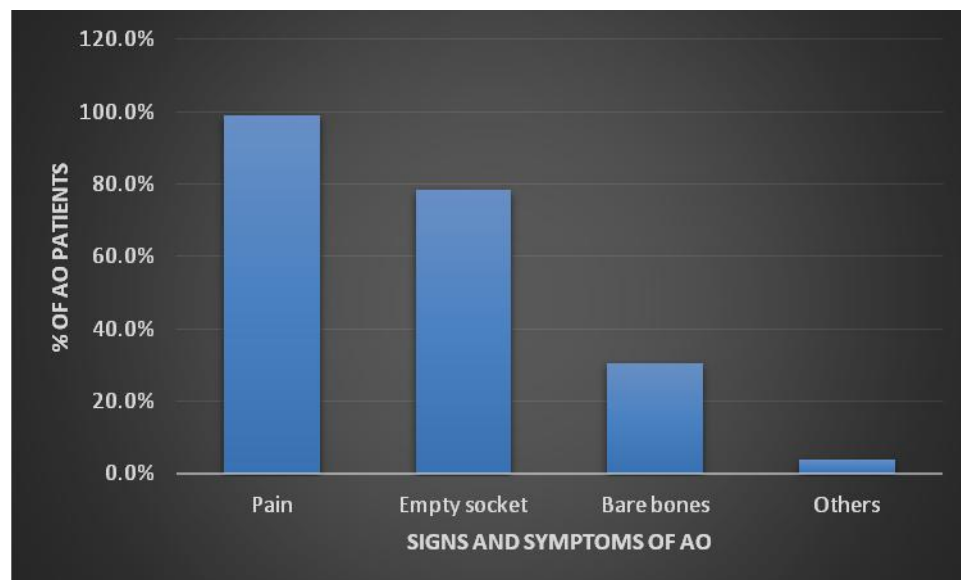
Figure 3.8: Distributions according to the signs and symptoms of AO.

3.2.15 Onset of Signs and Symptoms: Onset occurred most frequently one day after extraction 49 cases (48.0%), second day after extraction 27 cases (26.5%), third day cases 26 (25.5%) (Figure 3. 9).
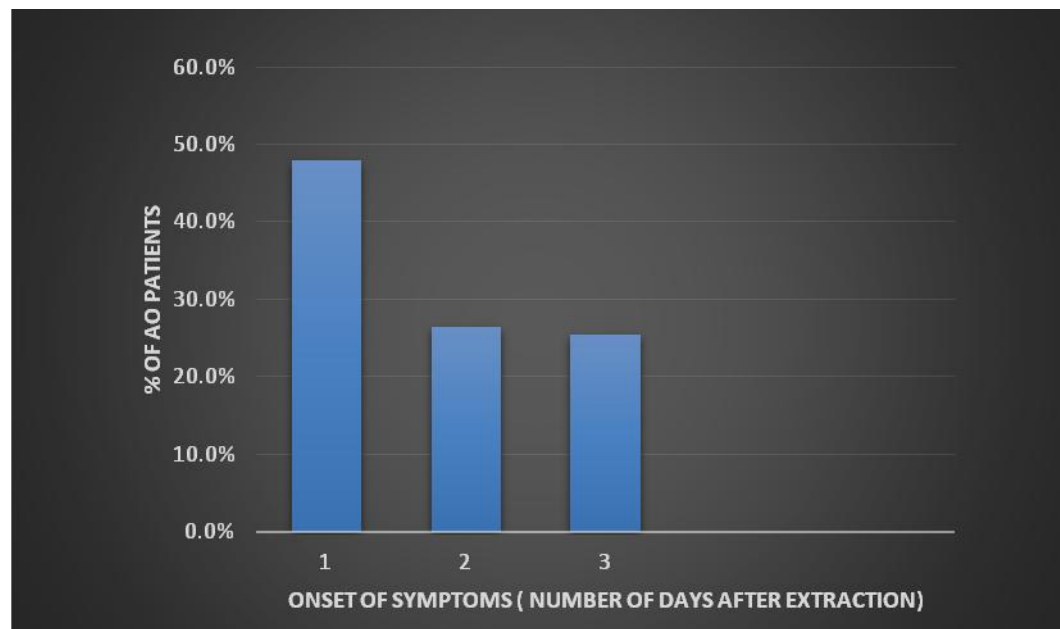

Figure 3. 9: Distributions according to the onsets of signs and symptoms of AO

Chapter 4: <u>Discussion</u>

In this present study, the incidence of AO was 4.6%. The reported incidences of 1-4%[1, 4] have been recorded in the literatures.   This difference could be a result of the variations of the diagnostic criteria and the method of assessment in regards to degree of impactions of third molars, age, surgical technique/skill and pain thresholds within the study population used by different researchers[28]. Some researchers required strict diagnostic criteria resulting in a lower incidence, other researchers including myself, used less strict diagnostic criteria and thus reported a slightly higher incidence[28]. Some literature review suggest a range between 4% -12%.[9,12,24,28-31]

Most researchers agreed that AO seldom occurs in childhood and that the incidence increases with age.[6] Almost no cases were reported before the age of 18 or after the age of 50.[6,28,31]   The finding of this study showed that the patients that presented with AO were in the age range of 20-30years, followed by the range of 31-40years (Figure 3.1). Nusair et al.[28] reported a peak incidence in the 18-33years age group. The reason for the prevalence of AO in this age group is still largely unclear, possible explanations for this include the presence of a well developed alveolar bone, less frequency of periodontal diseases in this age group resulting in difficult tooth extractions and subsequently development of AO and prevalence of female gender with AO in this age group (Figure3. 2). Kumar et al.[31] stated that AO is rarely seen before the age of 18 because bone marrow is haemopoietic type and after 40 years bone marrow changes to fat marrow, therefore the incidence of fibrinolytic alveolitis was minimum or none because of the absence of a stable tissue activator.[31] Another confounding factor may be prevalence of smoking in both genders in the age bracket. This can be explained by the daily observations of many young men and women in South African (social history) in which smoking habits are almost

identically distributed by between both sexes. This means equal numbers of both sexes are smokers.

The prevalence of AO was significantly higher in females (6.1%) than in males (3.1%) (RR 1.95; 95% CI: 1.31-2.91). Thus, females were 1.95 times more likely to develop AO, compared to males. This result is in disagreement with Nusair et al.[28] who reported a higher incidence in males than in females. Blum[14] stated that contradictory to studies conducted prior to 1960, studies from the 1970s and onwards showed a significant higher incidence of AO occurring in females. The use of oral contraceptives is thought to be the reason behind the increase susceptibility of females to AO. This study reported that out of the total 66 female patients of the AO group, 47 (71.2%) females were not on oral contraceptives, while 19 (28.8%) were on oral contraceptives. It is important to note that the dosage of oestrogen in oral contraceptives that are presently available in the market is far less than the dosage of oestrogen in the oral contraceptives that were available many decades ago. It has been proposed that oestrogen contained in oral contraceptives like pyrogens and certain drugs indirectly activate the fibrinolytic systems, and thus it is believed to contribute to the occurrence of AO by increasing the lysis of the blood clot.[14] Catellani et al.[32] concluded that the probability of AO increases with increased oestrogen dose in the oral contraceptives and that fibrinolytic activity appears to be lowest on Day 23 to Day 28 of the menstrual cycle.   The risk of dry socket associated with oral contraceptives can be minimized by performing extractions during days 23 through 28 of the tablet cycle[32.] Other researchers have studied the effect of oral contraceptives on the coagulation and fibrinolytic system and demonstrated an increase in the number of many factors such as Factor II (Prothrombin), Factor VII (Proconvertin), Factor VIII (Antihaemophilic), Factor X (Stuart-Prower) and particularly plasminogen.[14] Remarkably, a recent prospective randomized study reported that females have a

higher incidence of AO compared to males regardless of whether they are on oral contraceptives or not.[14] Garcia et al.[33] reported the result of their study which supported the view that oral contraceptives use increases the risk of AO specifically, the incidence of AO about 2-3times higher in women taking oral contraceptive than in the women not taking oral contraceptive. Muhonen et al.[34] observed that fibrinolysis activity is increased during menstruation, favouring AO in this period.

The prevalence of AO in this study for African was 4.5%, for Caucasian was 18.4 % (RR 0.89, 95% Cl 0.51-1.56), Coloured 2.3 % (RR 1.67, 95% Cl 0.83-3.36) and Asian was 3.9 % (RR 1.35, 95 CI 0.51-3.58). There was no significant difference in the prevalence of AO in the Caucasian, Coloured or Asian groups, compared to the African group. This result accurately represented the demographics of the races in South Africa. No reference exists till date in the literature correlating the incidence of AO with race.

The prevalence of AO in this study was higher in those with poor oral hygiene (9.9%) than in those with good oral hygiene (2.7%) (RR 3.65; 95% CI: 2.49-5.37). This result was statistically significant. Those with poor oral hygiene were 3.65 times more likely to develop AO, compared to those with good oral hygiene. The continuous alveolar contamination with saliva bacteria is an important factor for the onset of AO. Plaque and calculus serve as another source of bacteria in the oral cavity. The relationship between saliva bacteria and the onset of AO was supported by reports of this complication in some patients with poor OH (presence of plaque and calculus) and/or pre-existing local infection, such as pericoronitis and severe periodontal disease. Bacteria such as *Streptococcus beta- hemolyticus*, *Staphylococcus* and *Bacteroides melanogenicus* which are present in plaques and calculus in the oral cavity have fibrinolytic activity.[6]   These bacteria secrete pyrogens which stimulates fibrinolysis by promoting the conversion of proactivator to

activator, which in turn converts plasminogen to plasmin. Plasmin lyses blood clot and result in AO. *Treponema denticola* was postulated by Nitzan (1983) as an aetiologic agent in AO as it does not inhibit the mouth until the late adolescence and AO is rarely seen in childhood. *T. denticola* exhibits a strong plasmin like fibrinolytic activity.[6]

A study by Kolokythas, suggested that a relationship exists between some systemic diseases and AO.[3] In this study, 15(14.7%) of the AO patients had diabetes mellitus while 4(3.9%) of the AO patients were living with *HIV/AIDS*. Patients with diabetes mellitus have an increased risk of developing complications.[35] Hyperglycemia tissue interferes in every aspect of wound healing adversely affecting the immune system including lymphocyte and neutrophil function, chemotaxis and phagocytosis.[35] Studies with HIV- positive patients indicate that when the CD4 count reached levels below 50cells/mm[3,] there is significant risk in wounds, not healing. This study failed to show the prevalence of any medical condition such as HIV/AIDS and diabetes mellitus with AO simply because no data were collected for the non-AO patients with any of this condition who were included in this study.

In this study, 49% and 39.2% of the AO patients admitted that they consumed alcohol and smoked a cigarette(s) after the procedure respectively, while 1.0% abused drug substances. The consumption of alcohol and smoking was ascribed to the patients' failures to adhere to post-operatives instructions. Some researchers have reported that patients who smoked on the same day of the procedure had a higher incidence of AO than those who smoked on the 2nd or 3rd day post-operatively.[28] It has not been established whether a systemic mechanism or a direct local effect (heat and suction from smoking) on the extraction site is responsible for this occurrence.[28] It is believed that sucking effect created during smoking can dislodge the blood clot or disrupts its formation[14]. It is also believed that the increase incidence of AO was due to vasoconstrictive

action of nicotine on blood vessels which acts to reduce perfusion area and thus reduced blood supply.[14] No mention exist in the literature correlating the effects of heat from burning tobacco, contaminants in the smoke, or the systemic effects of the ingredients in cigarettes with AO.[14] This study failed to show any significant relationship between smoking and alcohol consumption with AO because no data were collected for non- AO patients who smoked and consumed alcohol and were included in the study.

The prevalence of AO was higher for patients operated on by dental students (6.4 %) than dentists (4.0%) (RR 1.60; 95% CI: 1.06-2.42). This result was statistically significant. Thus, patients operated on by dental students were 1.60 times more likely to develop AO, compared to those who had been operated on by dentists (Figure 3.6). There was no significant difference in the prevalence of AO between patients operated on by dentists 4.4% and registrars 4.4% (RR 1.11 95% Cl 0.58-2.14). Dental students are usually considered as less experience operators when compared with the dentists. This is result concur with that of Ogini et al.[29] who reported a higher incidence of AO in less experienced operators.

Some researchers reported in the literatures that AO is more prevalent in posterior mandibular teeth than in the posterior maxillary teeth, the site specificity hypothesis (Table 3.1). [9,28] It is my observation that this prevalence may be due to effect of the gravity which makes food particles and debris to be easily collected inside the alveolar sockets of most posterior mandibular teeth. Furthermore, the size of created surgical defect is relatively larger in the posterior mandibular teeth when compared with the anterior teeth. Parthasarathi et al.[9] reported that the most common hypothesis used to explain this finding is that the posterior teeth might experience trauma during extraction, which might increase the risk of development of AO. The mandible has less blood supply compared with the maxilla but more compact/ cortical bone (increase bone density) than

the maxilla. Nusair et al.[28] noted that some authors still believe that increased bone density, decreased vascularity, and a reduced capacity of producing granulation tissues are responsible for this site specificity.

This research showed that patients with 2 cartridges of local anaesthesia were 2.88 times more likely to develop AO, compared to those with only one cartridge (Figure3.7). Some researchers have mentioned the possibility of increased incidence of AO following the use of local anaesthesia with vasoconstrictors before extractions.[14,28] This was attributed to development of local ischaemia leading to poor blood supply to the socket.[28] However, subsequent studies indicate that ischaemia lasts only for one to two hours and is followed by a reactive hyperaemia which makes it of no importance to the subsequent disintegration of the blood clot.[28] Thus, it should be expected that there should an increase in the incidence of AO followed by an increased in the amount of local anaesthesia with vasoconstrictors administered. In this study, an average patient received 2 cartridges of 1.8ml local anaesthesia (2%lidocaine with 1:80,000 adrenaline). It is quite interesting to note that AO was also found in tooth extractions carried out under general anaesthesia where no vasoconstrictor was used. [14] Blum[14] reported that some researchers claimed an increase in the incidence of AO when periodontal ligamental (PDL) injections were used rather than block or infiltration injections. These findings have been attributed to the spread of bacteria, especially with multiple injections to the affected site. However, this was disputed by Tsirlis et al.[14] who have shown that PDL anaesthesia did not result in a higher incidence of AO than when block anaesthesia used[14].

Numerous studies indicated the incidence of AO was higher after single extractions than multiple extractions. The prevalence of AO was higher in those single extractions (5.3%) (RR 1.96; 95% CI: 1.15-3.37) than in those with multiple extractions (2.7%). This result was statistically

significant. Thus, those with single extractions were 1.96 times more likely to develop AO, compared to those with multiple extractions. This study finding is in agreement with Abu Younis et al.[24] who reported that the prevalence of AO was higher in the single extraction than in multiple extractions. This could be explained by the fact that multiple extractions are usually simple i.e. less traumatic because they are generally carried out on mobile periodontally compromised teeth unlike in single extractions which are considered to be more traumatic.[24,28]

The prevalence of AO was higher in trans-alveolar procedures 16.0% (RR 4.02; 95% CI: 2.53-6.39) than in intra-alveolar procedures (4.40%). This result was statistically significant. Thus, those with trans-alveolar procedures were 4.02 times more likely to develop AO, compared to those with intra-alveolar procedures. Chang et al.[12] reported a prevalence of 13.4%, while Nusair et al.[28] reported a prevalence of 20.1%. In this study, AO was found most commonly in the mandibular (3rd) molar teeth, followed by the first molar and second molar respectively (Table 3.1). This finding is in agreement with Nusair et al.[28]. Meanwhile it is in total contrast with Ogini et al.[29] which found the incidence of AO to be commonly in the first, second and third mandibular molars respectively. The number of the surgically extracted third molars may be responsible for this high incidence. This may reflect the effect of trauma rather than the extraction site (the particular tooth extracted). There seems to be a common assumption to make that all surgically extracted lower third molars must be traumatic but soft tissue impacted third molars extractions might be exemptions. Extractions of some teeth like upper canines and premolars with 2 long roots and some lower and upper first molar teeth may be more traumatic than the surgical extractions of lower third molars. Excessive trauma has been known to delay wound healing. This has been attributed to the compression of the bone lining the socket, which impairs its vascular penetration. On the other hand, excessive trauma may result in thrombosis in

the underlying vessels[14]. Birn[4] suggested that trauma during extractions damages the alveolar

bone cells, causing inflammation of the alveolar bone marrow and the subsequent release of

direct tissue activators into the alveolus, where they may precipitate fibrinolytic activity, thus

playing a major role in the pathogenesis of AO.

The prevalence of AO was significantly higher in patients who received irrigation (13.8%) (RR

4.13; 95% CI: 2.82-6.06) compared with those who did not receive irrigation (3.3%). This result

was statistically significant. Thus, those who received irrigation were 4.13 times more likely to

develop AO, compared to those who did not. In the present study the exact volume of irrigation

varied for each alveolus socket; however, no socket had irrigation of less than 50ml of normal

saline solution. Some researches postulated that vigorous, repetitive irrigation of the alveolar

socket might disturb the clot formation and give rise to AO while others believe that irrigating the

socket thoroughly would wash away bone debris, bacteria and other contaminants from the

socket.[36,37] Butler et al.[36] conducted a study in which bilateral mandibular molars were removed

surgically. Prior to closure, one surgical site received a lavage with 175ml of normal saline

solution and the opposite site received a less than 25 ml of the saline solution. Postoperative

comparisons revealed that use of 175ml saline solution lavage significantly reduced the incidence

of AO to approximately one-half that observed when minimal volume lavage was used[36].

Likewise, Cardoso et al.[1] also noted that irrigating the alveolus with varying amounts of

physiologic saline (25ml, 175ml, and 350 ml) progressively decreased the incidence of AO by

10.9%, 5.7%, 3.2% respectively. Motamedi MK[37] postulated the traditional end- of-surgery

irrigation of socket procedure may increase the risk of AO incidence, especially in older patients.

Younger patients were are more likely to experience socket wall bleeding and blood repopulation

even after extensive lavage as opposed to older patients.   Irrigation of the socket by large amount

of normal saline followed by suctioning of the socket may wash away blood clot, and bleeding may not repopulate the socket again. Natural socket bleeding at an extraction site creates a favourable environment for the formation of a blood clot necessary for good osseous healing of the socket. [37] This postulation does not rule the principle that irrigation should not be done in situations where there are visible debris and bone spicules in the socket, as the presence of bone spicules or debris either in the socket or subperiosteal flap can lead to subperiosteal abscess.[37] However, there is no standard published protocol on the irrigation of the alveolar socket; furthermore, it is difficult to establish what volume of solution can be regarded as excessive irrigation.

With regards to the prescription of post-operative medications to prevent the development of AO, analgesics, Penicillin and Metronidazole are the drugs on the post-operative medication scripts. Analgesics were prescribed to relieve pain, while the antibiotics Penicillin and Metronidazole were prescribed to prevent infections. Some researchers believed that systemic antibiotics should not be prescribed for the treatment of a true AO except in a known immune-compromised patient.[1,7,20, 21]

The clinical signs and symptoms of AO in this study were comparable to the generally described AO in most literatures.[14,24,28,29] Pain was found in almost all the patients with AO 101 (99%), while 80 (78%) of the AO patients had empty sockets. Thirty-one (30.4%) of the AO patients had sockets with bare bone while 4 (3.9%) of the AO patients had other symptoms such as halitosis, trismus, regional lymphadenopathy and pus formation inside the sockets (Figure3. 8). This study also showed that patients had more than one sign and symptom at the same time e.g. majority of patients presented with pain and empty sockets.

The average onset of symptoms was around 24 hours in 49 (48.0%) patients, 48 hours in 27 (26.5%) and 72 hours in 26 (25.5%) of patients (Figure 3. 9). The relative early onset could be attributed to the low pain threshold exhibited by the high number of patients, co-existence of AO signs and symptoms (pain, empty socket, and bare bones) with other post-operative complications such as trismus, swelling and halitosis followed traumatic surgical extractions. The intense neuronal pain of AO is believed to be related to the release of kinins, which are released immediately following tissue trauma.[14] This pain increases in intensity and cannot be relieved by over the counter analgesics. Plasmin is involved in the conversion of kallikreins to kinins in the bone marrow.[14] The presence of plasmin is a possible explanation for the intense pain and disintegration of a blood clot.[14] Cases, in which the onset was delayed a bit, could be that infection was needed to liberate tissue activators and pain mediators.[14] Halitosis was more frequently found in patient with poor OH; food debris collected in the empty socket and its subsequent fermentation by bacteria was believed to be the cause of the problem of halitosis.

Chapter 5: <u>Conclusion:</u>

This study found statistically significant association between the development of AO and the following variables: gender (more for female), poor oral hygiene status, single extractions, the amount of local anaesthetic administered, the use of irrigation during extraction, third molar extractions (surgical trauma) and the level of operator experience. On the other hand, there was no statistically significant association found between the development of AO and the following variables: age, race, medical history, social history, the method of sterilization, prescription of post-operative medication, and post-operative instruction to the patients. The prevalence of AO is comparable to those reported in the literature.[9,28,29] Most of the current literature has always reinforced preventative methods as the main key to preventing AO.[1,3,4] A better knowledge of the prevalent variables (risk factors) of AO would help dentists considerably with anticipating the development of this complication in patients at risk and how such patients can be identified and advised accordingly. In the long run, this will decrease the incidence of this complication which will in turn decrease the subsequent treatment required to treat it and minimize the associated health care cost involved.

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