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Prevalence, Clinical Picture, and Risk Factors of Dry Socket in a Jordanian Dental Teaching Center

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Abstract

Aims: The aims of this study were to determine the prevalence, clinical picture, and risk factors of dry socket at the Dental Teaching Center of Jordan University of Science and Technology (DTC/JUST).

Methods and Materials: Two specially designed questionnaires were completed over a four-month period. One questionnaire was completed for every patient who had one or more permanent teeth extracted in the Oral Surgery Clinic. The other questionnaire was completed for every patient who returned for a post-operative visit and was diagnosed with dry socket during the study period.

Results: There were 838 dental extractions carried out in 469 patients. The overall prevalence of dry socket was 4.8%. There was no statistically significant association between the development of dry socket and age, sex, medical history, medications taken by the patient, indications for the extraction, extraction site, operator experience, or the amount of local anesthesia and administration technique used. The prevalence of dry socket following non-surgical extractions was 3.2%, while the prevalence following surgical extractions was 20.1% ($P < 0.002$). The prevalence of dry socket following surgical and non-surgical extractions was significantly higher in smokers (9.1%) than in non-smokers (3%) ($P = 0.001$), and a direct linear trend was observed between the amount of smoking and the prevalence of dry socket ($P = 0.034$). The prevalence of dry socket was significantly higher in the single extraction cases (7.3%) than in the multiple extraction cases (3.4%) ($P = 0.018$). The clinical picture and management of dry socket at DTC/JUST were similar to previous reports in the literature. The prevalence of dry socket, its clinical picture, and management at DTC/JUST are similar to those reported in the literature.

Conclusion: Smoking and surgical trauma are associated with an increased incidence of dry socket. Moreover, patients who had single extractions were more likely to develop dry socket than those who had multiple extractions in the same visit.

Keywords: Dry socket, incidence, signs, symptoms, risk factors, Jordan

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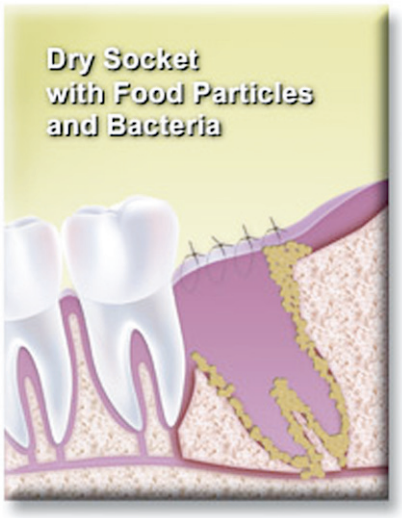
Introduction

Dry socket is one of the most common complications of tooth extraction and is characterized by severe pain starting usually on the second or third day postoperatively. Its prevalence has been reported to vary from 0%[1] to more than 35%[2] and is more common following mandibular third molar extraction.[3-9] Patients experience pain and may experience loss of productivity. This makes the condition costly to both patient and society, as 45% of patients require multiple postoperative visits in the process of managing this painful condition.[10]

The exact pathogenesis of dry socket is not well understood. However, disintegration of the blood clot by fibrinolysis remains the most widely accepted theory.[11] Several contributing factors have been reported to be associated with an increased risk of dry socket. They include traumatic extraction,[3-4,11] preoperative infection,[11-12] smoking,[13] sex,[11,14] site of extraction,[8,14] use of oral contraceptives,[15] use of local anesthetics with vasoconstrictors,[16] inadequate postoperative irrigation,[17] and low level of operator experience.[4,8]



Several methods have been advocated to reduce the incidence of dry socket including the use of antiseptic mouthwashes[18-20] antifibrinolytic agents,[21] antibiotics,[22-23] steroids,[24] clot supporting agents,[25] and other intra-alveolar dressings and medicaments.[9,27-28]

While this condition cannot be completely treated as long as the exact etiology is not firmly established, its management appears to be simple and effective. It usually involves reassurance of the patient, cleaning and irrigation of the affected socket, and insertion of a medicated pack.[2,25,29-30]

This is the first study of dry socket at the Dental Teaching Center of Jordan University of Science and Technology (DTC/JUST) and in Jordan . Its aims were to identify the prevalence and risk factors as well as to describe the clinical picture of this painful condition at this Jordanian dental teaching center.

Methods and Materials

The DTC/JUST was the setting for the study. This center is located in Irbid, in North Jordan, and is involved in the training of undergraduate and postgraduate dental students. It serves the community of the city of Irbid and its neighboring towns and villages, which have a total population of approximately 750,000.

This prospective study was totally observational without any interference with any of the clinical procedures normally followed at DTC/JUST.

Description of the Sample

During the study period, 838 permanent tooth extractions were carried out in 469 patients. There were 225 (48.0%) male patients and 244 (52.0%) female patients. The age of patients

ranged from 11 to 80 years with a mean of 36.96 (±15.53) years.

Data Collection

Data were collected over a period of four months using two questionnaires. The first questionnaire was completed for each patient who had an extraction of one or more permanent teeth at the Oral Surgery Clinic. Patients who had only deciduous teeth extracted were not included in the study. The questionnaire was completed by the person who performed the extraction. It included items such as patient demographic data, smoking habits, medical history and medications, teeth extracted, indication for the extraction for each tooth, extraction technique, level of experience of the operator who performed the extraction, amount and technique of local anesthesia, and postoperative medications. If the extracted tooth was an impacted third molar, its depth and angulation were also recorded (Figure 1).

The second questionnaire was completed for each patient who came back to the clinic during the study period and was diagnosed with a dry socket. A modification of the Blum's definition of dry socket was adopted in this study.[25]

Patients were diagnosed with a dry socket if they had at least two of the following signs and symptoms:

a. Empty socket with or without food debris
b. Pain in or around the socket occurring any time within one week of the extraction

This questionnaire was completed by one of the researchers and included items such as the patient demographic data, socket affected, signs and symptoms, onset of symptoms, and treatment provided (Figure 2).

Study Groups

Patients were divided into four age groups as follows: <18 years, 18-33 years, 34-49 years, and ≥50 years. These four groups were then organized as follows:

1. The extracted teeth were classified according to their anatomical location into upper anterior teeth, upper posterior teeth, lower anterior teeth, and lower posterior teeth.
2. Extraction techniques were classified into:
   - Non-surgical extractions (extractions which needed simple elevation or root separation without reflecting a mucoperiosteal flap).
   - Surgical extractions (extractions which involved the reflection of a mucoperiosteal flap with or without bone removal).
3. Local anesthetic techniques were classified into:
   - Infiltration anesthesia
   - Regional block anesthesia
4. Amount of local anesthesia used was divided into two categories: <2 cartridges and ≥2 cartridges per tooth.
5. Patients were divided according to their medical history into two groups: medically fit patients and patients with systemic diseases.
6. Patients were divided according to their smoking habit into:
   - Non-smokers: patients who did not smoke and x-smokers
   - Smokers: patients who smoked up to 20 cigarettes per day
   - Heavy smokers: patients who smoked more than 20 cigarettes per day and those who smoked a water pipe (Shisha) regularly.

Data Analysis

Data were then analyzed using SPSS® for Windows (version 9; SPSS Inc, Chicago, IL, USA) and Epi-info® (CDC, Atlanta, GA, USA) statistical software. Descriptive statistics and bi-variant data analysis using chi-square tests were done as appropriate. The critical level of significance was set at $P < 0.05$. Multiple binary logistic regression was used to test for the significance of associations between selected variables after adjusting the effect of others.

Results

A total of 122 (26%) patients were smokers, of whom 33 (7% of the total sample) were heavy smokers (smoked more than 20 cigarettes per day). The proportion of smokers was higher in the male group than in the female group (44.9% and 8.6%, respectively). Although the majority of patients (358 (76.3%)) were fit and healthy at the time of extraction, 111 (23.7%) had varying underlying systemic conditions and 90 (19.1%) were taking different medications (Tables 1 and 2).

Figure 1. Questionnaire used for all subjects.

Dry Socket in the Dental Teaching Center
Extraction Sheet

Please check all that apply

Patient's name: _____ File number: _____ Date: _____

Gender: ☐ Male ☐ Female Age: _____ years

Smoking: ☐ No ☐ Yes _____ cigarettes / day

Medical History: _____

Medications: _____

Teeth Extracted: _____|_____

Reason for extraction: ☐ Advanced caries ☐ Advanced periodontal disease
☐ Orthodontic treatment ☐ Pericoronitis
☐ Others, specify _____

Extraction technique: ☐ Simple elevation ☐ Root separation
☐ Flap without bone removal ☐ Flap with bone removal

Operator: ☐ 4th year dental student ☐ 5th year dental student
☐ Resident ☐ Postgraduate student
☐ Consultant

Number of local anaesthetic cartridges used: _____

Technique of local anaesthesia: ☐ Labial/ buccal infiltration ☐ Lingual/ palatal infiltration
☐ ID/ lingual block ☐ Mental block

If the tooth is an impacted wisdom tooth:

Depth of impaction: ☐ Partially erupted
☐ Soft tissue impaction
☐ Bony impaction

Angulation: ☐ Vertical
☐ Mesioangular
☐ Distoangular
☐ Horizontal
☐ Other, specify _____

Postoperative instructions given? ☐ Yes ☐ No

Postoperative medications prescribed: _____

_____

Figure 2. Questionnaire used for subjects with a dry socket.

Dry Socket in the Dental Teaching Center
Dry Socket Sheet

Please tick all that apply:

Patient's name: _____ File number: _____ Date: _____

Gender: ☐ Male ☐ Female Age: _____ years

Socket affected: _____|_____

Signs and symptoms:
- ☐ Pain
- ☐ Empty socket
- ☐ Bare bone
- ☐ Halitosis
- ☐ Others: _____

Onset of symptoms:
- ☐ Immediately after extraction
- ☐ 24 hours after extraction
- ☐ 48 hours after extraction
- ☐ 72 hours after extraction
- ☐ Other, specify _____

Treatment provided:
- ☐ Irrigation with normal saline
- ☐ Packing with Alvogyl
- ☐ Medications: _____

Upper anterior teeth and upper posterior teeth constituted 105 (12.5%) and 324 (38.7%) of the total number of extractions, respectively, whereas lower anterior teeth and lower posterior teeth constituted 98 (11.7%) and 311 (37.1%) of the total number of extractions, respectively. A total of 761 (90.9%) extractions were non-surgical (731 (87.2%) simple elevations and 30 (3.6%) root separations), while 77 (9.1%) teeth needed surgical extraction (59 (7%) needed a flap with bone removal and 18 (2.1%) needed only a flap without bone removal).

Undergraduate and postgraduate students carried out 743 (88.7%) extractions [(182 (21.7%) by fourth year students, 460 (54.8%) by fifth year students, and 101 (12.2%) by postgraduate students)], while consultants and resident dentists carried out 50 (6%) and 45 (5.3%) extractions, respectively.

Advanced caries was the most common cause of extraction and lead to the extraction of 345 (41.2%) teeth. This was followed by periodontal diseases, which accounted for 200 (23.9%) extractions. A combination of caries and periodontal disease was the reason behind the extraction of 158 (18.9%) teeth. In addition, pericoronitis and orthodontic treatment were the indications for the extraction of 66 (7.9%) and 50 (6%) teeth, respectively. Only 19 (2.3%) teeth were extracted because of a missing opposing tooth.

Table 1. Summary of the medical history of the study population.

Medical History	Number of Patients	Percentage (%)
None	358	76.3%
Diabetes Mellitus (DM)	19	4.1%
Hypertension (HT)	17	3.6%
Ischemic heart disease	3	0.6%
DM and HT	4	0.9%
Asthma	12	2.6%
Chronic bronchitis	3	0.6%
Previous surgery	24	5.2%
Rheumatoid arthritis	4	0.9%
Psychological disorders	6	1.3%
Anemia	5	1.1%
Peptic ulcer	3	0.6%
Osteoporosis	3	0.6%
Hepatitis B	2	0.4%
Renal stones	2	0.4%
Hyperthyroidism	1	0.2%
Epilepsy	1	0.2%
Migraine	1	0.2%
Prosthetic heart valve	1	0.2%
Total	**469**	**100%**

Table 2. Medications used regularly by the study population at the extraction.

Medication	Number of Patients	Percentage (%)
None	379	80.9%
Paracetamol	13	2.8%
NSAID's	8	1.7%
Oral contraceptives	6	1.3%
Antihypertensive drugs	15	3.2%
Hypoglycemic agents	15	3.2%
Insulin	8	1.7%
Steroids	5	1.1%
Warfarin	6	1.3%
Ferrous sulphate	3	0.6%
Ipratropium bromide	2	0.4%
Salbutamol	2	0.4%
H2-blockers	2	0.4%
Antidepressant drugs	2	0.4%
Carbimazole	1	0.2%
Sodium valproate	1	0.2%
Ergotamine	1	0.2%
Total	**469**	**100%**

A total of 131 mandibular third molars were extracted, of which 74 (56.6%) were impacted and needed surgical extraction. Of the impacted ones, 47 (63.5%) were partially erupted, 23 (31.1%) were covered with soft tissues, and 4 (5.4%) were covered with bone. The angulation of 29 (39.2%) impacted lower third molars was vertical, 24 (32.4%) were mesioangular, 12 (16.2%) were horizontal, and 9 (12.2%) were distoangular.

All teeth were extracted under local anesthesia using 2% Xylestesin® (Lidocaine) with 0.015 mg/ml epinephrine (3M ESPE AG, Seefeld, Germany). Infiltration around the tooth was used in 470 (56.1%) extractions, while regional block anesthesia was used in 368 (43.9%) extractions. The amount of local anesthesia used was less than two cartridges per tooth in 484 (57.8%) extractions and two or more cartridges per tooth in 354 (42.2%) extractions.

All patients received oral postoperative instructions by the operators. Post-extraction medications were prescribed for 176 (37.5%) patients. Analgesics (ibuprofen and/or paracetamol) were prescribed alone for 130 (27.7%) patients, whereas a combination of antibiotics (either amoxicillin or metrondizole or both) and pain killers were prescribed for 46 (9.9%) patients.

Dry Socket Prevalence

The overall prevalence of dry socket was 4.8% (40 dry sockets in 838 extractions). Some patients developed more than one dry socket, which made the overall prevalence per patient 6.4% (30 patients with dry sockets out of 469 patients who had extractions). In addition, dry socket prevalence (per tooth) following non-surgical extractions was 3.2% (24 of 761), while it was 20.1% (16 of 77) following surgical extractions. This difference was statistically significant ($P < 0.002$) (Figure 3).

There was no statistically significant association between the development of dry socket and patient's age, sex, medical history, medications (preoperative or postoperative), indications for extraction, operator's experience, and the amount or technique of local anesthesia.

Patients who developed dry sockets were 16 (53%) males and 14 (47%) females. The prevalence of dry socket in female patients was 4.3% (14 dry sockets in 327 extractions) compared to 5.1% (26 dry sockets in 511 extractions) in male patients. This difference was statistically insignificant ($P = 0.553$).

The peak prevalence of dry socket was in the 18 to 33 year age group and was 7.9% (21 dry sockets in 266 extractions) compared to 2.7%

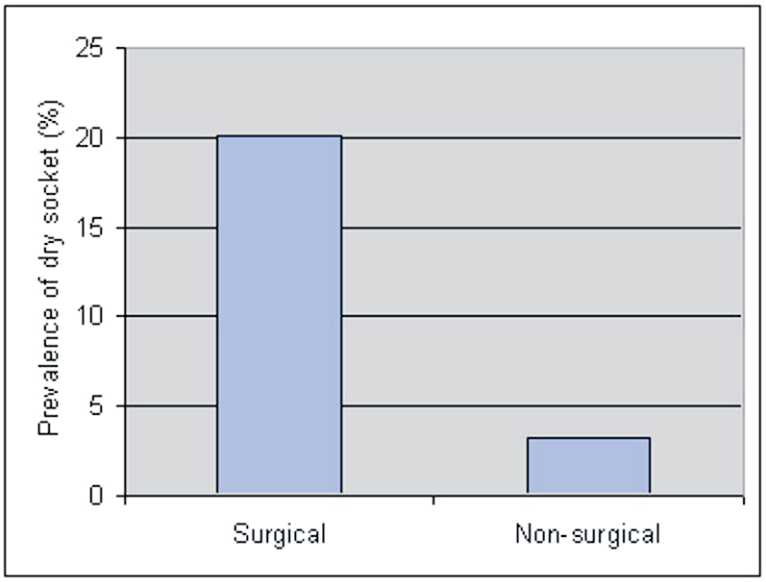


Figure 3. Prevalence of dry socket following surgical and non-surgical extraction.

(7 dry sockets in 263 extractions) in patients whose ages ranged from 34 to 49 years and 4.3% (12 dry sockets in 281 extractions) in patients who were older than 50 years. None of the patients under 18 years of age developed dry sockets. These differences were statistically insignificant (P = 0.383).

Regarding extraction technique and operator's experience, the prevalence of dry socket was 3.3% (21 of 642) and 2.1% (1 of 49) following non-surgical extractions performed by undergraduate and postgraduate students, respectively. This difference was statistically insignificant (p = 0.588).

Following surgical extractions, the prevalence of dry socket was 23.1% (12 of 52) when postgraduate students performed the extractions and 18.2% (4 of 22) when consultants performed the extractions. This difference was also statistically insignificant (P= 0.513). In addition, the prevalence of dry socket was 2.2% (1 of 45) following extractions performed by resident dentists.

A possible relation between the anesthetic techniques and dry socket development was investigated through analysis of data related to extractions of lower anterior teeth (the only area in which different anesthetic techniques were used). The prevalence of dry socket was 8.1% (5 of 62) following regional block anesthesia (inferior alveolar and lingual nerve block) and 5.5% (2 of 36) following infiltration anesthesia. This difference was statistically insignificant (P = 0.473). In addition, the prevalence of dry socket following the use of less than two cartridges of local anesthesia per tooth was 3.5%, whereas it was 6.5% following the use of two cartridges or more. This difference was also statistically insignificant (P = 0.187).

The prevalence of dry socket was 9.1% (23 dry sockets in 263 extractions) following extractions in smokers and heavy smokers compared to 3% (17 dry sockets in 575 extractions) in non-smokers. This difference was statistically significant (P = 0.001).

In addition, the prevalence of dry socket was 6.1% and 17.1% following extractions in smokers and heavy smokers, respectively. This difference was statistically significant (P = 0.002) (Figure 4).

When anatomical site was considered, there were 6 (15%) cases of dry socket in the upper jaw compared to 34 (85%) cases in the lower jaw. The prevalence of dry socket was 1.4% following maxillary extractions and 8.3% following mandibular extractions. This difference was statistically significant (P = 0.002) (Figure 5).

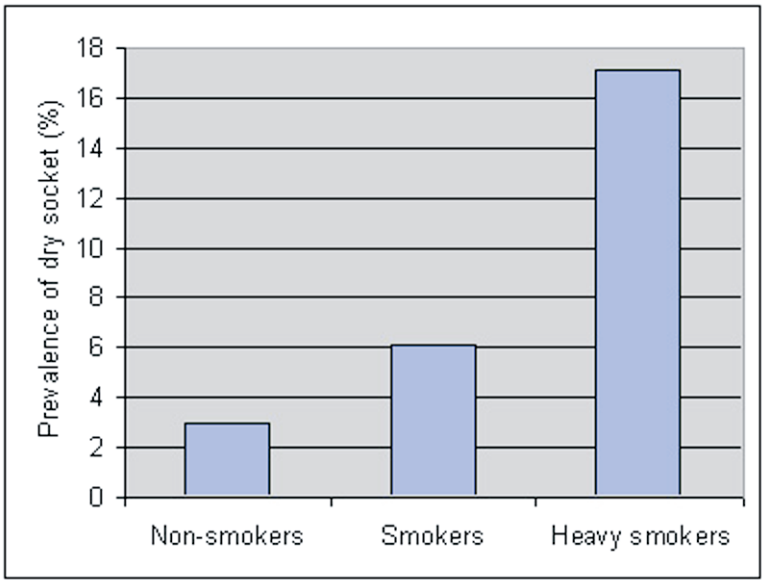


Figure 4. Prevalence of dry socket in relation to smoking.

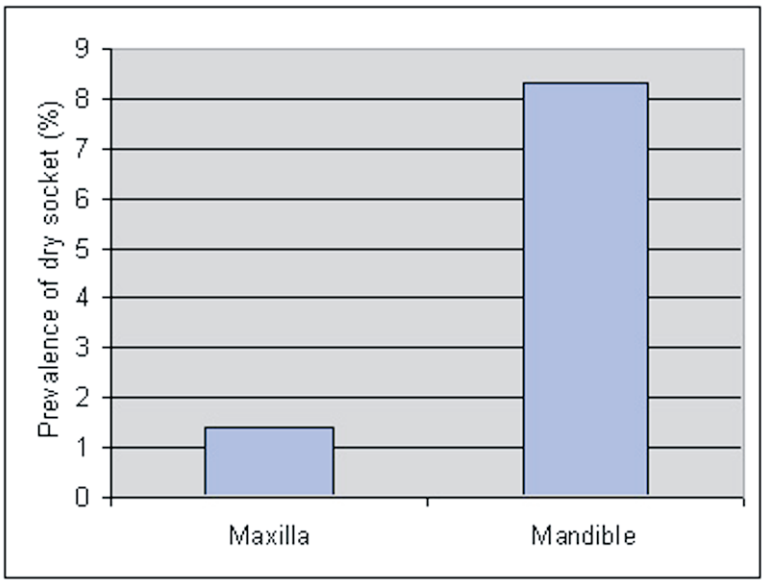


Figure 5. Prevalence of dry socket in the maxilla and mandible.

Also, the prevalence of dry socket was highest following the extraction of lower posterior teeth at around 8.7% (27 of 311). The next highest was dry socket occurring after extraction of lower anterior teeth at 7.1% (7 of 98), followed in order by 2.8% (3 of 105) after the extraction of upper anterior teeth, and a prevalence of 0.9% (3 of 324) following the extraction of upper posterior teeth. The differences in dry socket between anterior and posterior teeth within the same jaw were statistically insignificant.

There were a total of 17 lower wisdom teeth surgically extracted and subsequently developed dry sockets. Of these, ten (58.8%) were partially erupted and seven (41.2%) were soft tissue impacted. None of them (0.0%) were bony impacted.

The prevalence of dry socket following extraction of partially erupted and soft tissue impacted molars was 21.3% (10 of 47) and 30.4% (6 of 23), respectively. This difference was statistically insignificant (P = 0.736). In addition, vertical angulation was found in eight cases of impacted wisdom teeth which developed dry socket, whereas six and three cases were in mesioangular and distoangular angulation, respectively.

Extractions of wisdom teeth with horizontal angular position were not followed by dry sockets. The incidence of dry socket following the extraction of wisdom teeth in a vertical position was 27.6% (8 of 29), and it was 25% (6 of 24) and 33.3% (3 of 9) following the extraction of lower third molars in mesioangular and distoangular positions, respectively. These differences were also statistically insignificant (P = 0.902).

Patients were grouped into single-extraction cases (302) and multiple-extraction cases (167). The prevalence of dry socket in the first group was 7.3% (22 of 302), while in the second group it was 3.4% (18 of 536). This difference was statistically significant (P = 0.018) (Figure 6).

Clinical Picture of Dry Socket

Regarding the clinical picture of dry socket, a combination of pain, empty socket, bare bone, and halitosis were the presenting signs and symptoms in 16 (40%) dry socket cases. This was followed by the presence of pain, empty socket, and bare bone without halitosis in 14 (35%) cases. Pain, empty socket, and halitosis were present in four (10%) cases, and only pain with empty socket was present in six (15%) cases. Thus, pain and empty socket were present in 40 (100%) cases, bare bone was present in 30 (75%) cases, and halitosis was present in 20 (50%) cases (Figure 7).

The onset of symptoms was found to range from immediately to 72 hours after the extraction with a mean of 36.6 hours. Symptoms started immediately after the extraction in two cases (5%),

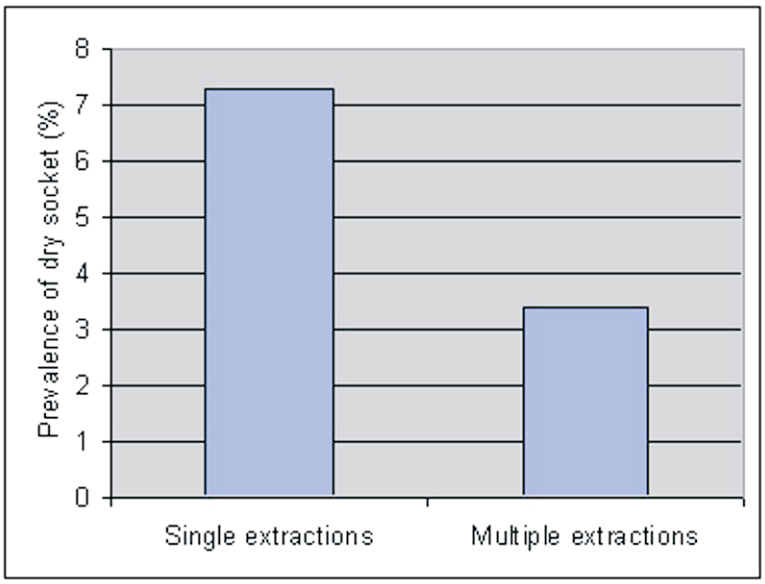


Figure 6. Prevalence of dry socket following single and multiple extractions.

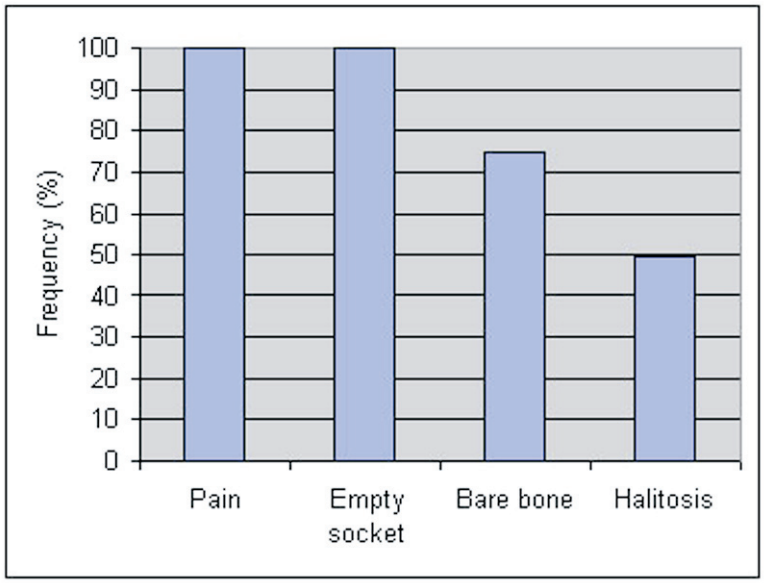


Figure 7. Frequency distribution of dry socket signs and symptoms.

following 24 hours in 20 (50%) cases, following 48 hours in 13 (32.5%) cases, and following 72 hours in 5 (12.5%) cases (Figure 8).

With regards to management of dry socket, all affected sockets were irrigated with normal saline and Alvogyl packing was used in 33 (82.5%) cases. Thirteen patients had medications prescribed. These were pain killers (ibuprofen and/or paracetamol) in ten (33.3%) cases and a combination of painkillers, metrondizole, and Chlorhexidine mouthwash in three (10%) cases.

Discussion

Dry socket is a clinical complication of considerable importance. It is characterized by severe pain starting usually on the second or third day postoperatively. The generally accepted etiology of dry socket is an increased local fibrinolysis leading to disintegration of the

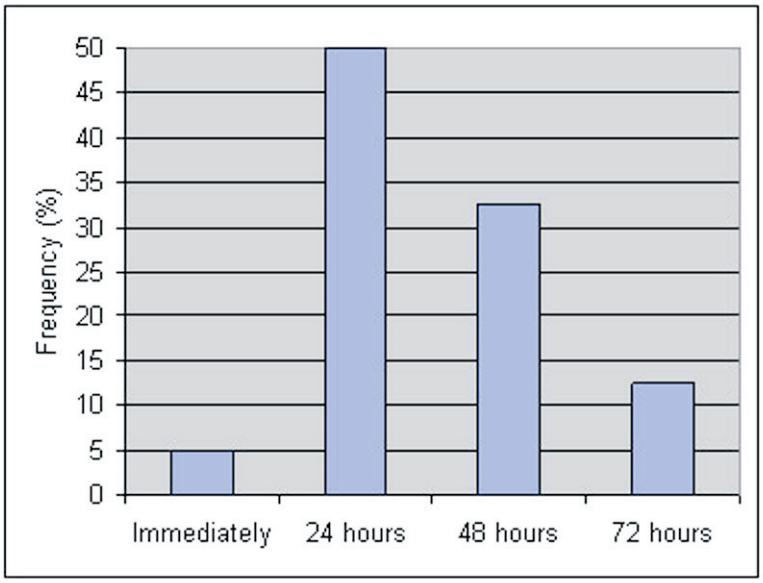


Figure 8. Frequency distribution of dry socket cases according to onset time.

clot.[11] Some antifibrinolytic agents when placed topically in the extraction site have been shown to decrease the incidence of dry socket.[41] Surgical trauma, which leads to liberation of different tissue activators, and bacterial infections remain the two most acceptable initiating factors of this localized fibrinolytic activity.[11]

The results of this study show the prevalence of dry socket at the DTC/JUST and its clinical features are generally similar to those reported in the literature. The overall prevalence of dry socket was 4.8%, which is only slightly higher than the overall prevalence of 2-4% reported in the literature.[5-7,14]

This difference could possibly be attributed to variations in the diagnostic criteria required by different researchers. While some required strict diagnostic criteria and reported a lower incidence,[5,14], others were not as strict and reported a higher incidence.[6,8] In this study a minimum of pain and an empty socket with or without food debris were considered diagnostic.

Another possible explanation for this slightly higher than expected figure is it reflects the overall prevalence following all extractions, including surgical ones. It is well documented surgical extractions result in a higher dry socket prevalence.[3,9-10,42] If surgical extractions are excluded, the prevalence of dry socket following non-surgical extractions becomes 3.2% which is comparable to previous reports in the literature.

It is widely accepted the prevalence of dry socket increases with the increase in extraction difficulty.[11,14,25,31] This could be due to more liberation of direct tissue activators secondary to bone marrow inflammation following the more difficult and, hence, more traumatic extractions.[11] In the current study surgical extractions were associated with a significantly higher incidence of dry socket (20.1%), which is consistent with what is well documented in the literature and may give some support to trauma as a contributing factor in the pathogenesis of dry socket.

A number of previous studies[6,14] indicated the prevalence of dry socket was higher after single extractions than multiple extractions, and this was confirmed by the results of this study in which dry socket prevalence was 7.3% following single extractions and 3.4% following multiple extractions.

This difference could possibly be explained by less pain tolerance in patients with single extractions compared to those with multiple extractions who allow their teeth to deteriorate to such an extent multiple extractions are needed and relieve the preoperative pain.[6] In addition, multiple extractions are usually simple (atraumatic) because they are generally performed on mobile teeth which are periodontally compromised. This is also consistent with the findings of Krough[32] who suggested if several adjacent teeth are to be extracted, the best postoperative healing would follow their extraction in one operation.

In this study the difference in the prevalence of dry socket between males (5.1%) and females (4.3%) was statistically insignificant. Although this is similar to the findings of Al Khateeb et al.,[12] it is in disagreement with the results of several other studies[5-6,33] including MacGreoger[14] who reported a higher incidence of dry socket in females with a male:female ratio of 2:3.

This can be explained by the fact, unlike Western societies in which smoking habits are almost identically distributed among both sexes, the percentage of female smokers in this study was much less than males (8.6% and 44.9%, respectively). Thus, any increased susceptibility of the female sex to dry sockets may have been compensated for by the effect of smoking in the male group of patients.

Another possible explanation is most studies reporting a higher incidence of dry socket in females had a much higher percentage of oral contraceptive users than this study (3%). The use of contraceptives thought to be the reason behind the increased susceptibility of females to dry socket[3,30,33-34] was minimal in this study.

The findings of this study also showed the prevalence of dry socket to be highest in the third and fourth decades of life with a peak incidence in the 18-33 year age group which is in agreement with the findings of many other studies.[5-6,8,12,14] The reason for this age dependence is still unclear, but the presence of well developed alveolar bone and the relative infrequency of periodontal diseases at this age (both make tooth extraction more difficult) may provide a possible explanation.[6] Most surgical extractions in this study were performed in this age group, and surgical extractions are associated with a higher incidence of dry socket.

Although the present study results were in agreement with part of the claim made by Hermesch et al.[38] showing no dry sockets in patients less than 18 years of age, it contradicted their other study by demonstrating six cases of dry socket in patients above the age of 50 years.

Contrary to the findings of Johnson and Blanton,[35] who reported no significant difference in the prevalence of dry socket between smokers and non-smokers, a dose dependent relationship between smoking and the occurrence of dry socket was demonstrated in the present study which is similar to the findings of other studies.[13,42]

However, the increased prevalence of dry socket among smokers may also be attributed to their failure to adhere to postoperative instructions. It has been reported patients who smoked on the same day of surgery had a higher incidence of dry socket than those who smoked on the second day postoperatively.[42] Whether a systemic mechanism or a direct local affect (heat and suction) on the extraction site is responsible for this increase in the occurrence of dry socket is unclear.

Many workers reported site specificity in the occurrence of dry socket with the mandibular molar area being the most commonly affected

site.[6,8,23,14] Although there is no scientific evidence of insufficient blood supply due to normal anatomical structure around the sockets of the mandibular molars and no evidence of any connection between dry socket and insufficient blood supply,[11] some authors still believe increased bone density, decreased vascularity, and a reduced capacity of producing granulation tissue are responsible for this site specificity.[5] It was also suggested this site specificity could be explained in terms of difficulty of extractions.[14] In this study, although there was a statistically significant difference between upper and lower jaws in terms of dry socket incidence (p=0.002), the differences were statistically insignificant between anterior and posterior regions within the same jaw.

In agreement with the findings of other authors[5,7] the results of the present study have shown dry socket is more common following the extraction of mandibular third molars followed by first and second mandibular molars. This is probably due to the large percentage of surgically extracted mandibular third molars (56.6%) and may reflect the effect of surgical trauma rather than the anatomical site. If non-surgical extractions only were considered, dry socket would be seen most commonly after the extraction of the mandibular first molar followed by second and third mandibular molars, respectively. This is in agreement with results of both Oginni et al.[8] and MacGreoger,[14] whose studies involved mainly non-surgical extractions.

Undergraduate and postgraduate students carried out most of the non-surgical extractions during the study period, whereas most of the surgical extractions were performed by postgraduate students and consultants. There was no significant difference in the incidence of dry socket following non-surgical extractions performed by undergraduate and postgraduate students (p = 0.558) and following surgical extractions performed by postgraduate students and consultants (p = 0.513). Thus, the present study has failed to demonstrate the operator's experience as a risk factor for the development of dry socket. Although this is in agreement with the findings of Larsen[10] and Field et al.,[6] it is different from those of Oginni et al.[8] and Alexander[4] who reported a higher incidence of dry

socket following extractions performed by the less experienced operators.

The failure of this study to demonstrate a lower prevalence of dry socket following non-surgical extractions performed by postgraduate students could be explained by noting postgraduate students usually performed more difficult extractions than those of undergraduate students although both were included under non-surgical extractions. Moreover, patients who usually presented to postgraduate students kept their follow-up appointments (and, hence, they were more likely to be diagnosed with dry sockets) opposite to those who presented to undergraduate students.

The increased difficulty of surgical cases performed by consultants and the different quality of patients presented to them may also be possible causes of the failure of this study to demonstrate a lower incidence of dry socket following surgical extractions performed by consultants. For the most part, patients who presented to consultants were in the high income and social group of patients; and so they may have had a lower pain tolerance and paid more attention to postoperative complications.

Even though some researchers suggested a relationship between some systemic diseases and dry socket,[11,3] in this study no significant difference was found between the incidence of dry socket among medically fit patients and those with underlying systemic diseases. This was in agreement with MacGreoger[14] and Oginni et al.[8] With regards to medications, only oral contraceptives have been reported to be associated with an increased risk of dry socket.[3,15,33-34] However, such a relationship was

not found in this study probably because of the small number of patients who were on oral contraceptives.

Regarding the reason for tooth extraction and its effect on the incidence of dry socket, the results of this study have shown no significant association. This is in agreement with other studies.[11,14,32] The only exception is teeth with pericoronitis which have been linked to a higher prevalence of dry socket. This, however, could not be demonstrated in this study and the reason was probably the small number of such cases in the study population.

It has been mentioned, but not conclusively proven, there is a possibility of an increased incidence of dry socket following the use of local anesthesia with vasoconstrictors before the extraction.[11] Although Krogh[32] emphasized the incidence of dry socket was highest in the mandibular molar area (where regional block anesthesia is used), Lehner[43] found a higher incidence of dry socket when infiltration anesthesia was used and concluded infiltration anesthesia gave rise to a temporary ischemia leading to poor blood supply to the socket. However, subsequent studies indicate ischemia lasts only for one to two hours and is followed by a reactive hyperemia which makes it of no importance to the subsequent disintegration of the blood clot.[11,36] This concept is currently widely accepted.

In this study there was no significant difference in dry socket prevalence following the extraction of teeth requiring infiltration anesthesia and those requiring regional block anesthesia (both contained adrenaline). These results are in agreement with the assumption local ischemia due to vasoconstrictors in local anesthesia have no role in the pathogenesis of dry socket.

In the same context if there is a possible role for local ischemia in the etiology of dry socket, one should expect an increased incidence of dry socket following the use of an increased amount of local anesthesia with a vasoconstrictor. This study also failed to find any significant difference following the use of different amounts of local anesthesia (< two cartridges and ≥ two cartridges). However, these results should be interpreted with caution and considered inconclusive since regional block anesthesia was used in the majority of extractions requiring two or more cartridges of local anesthesia; so, any resulting ischemia would be located away from the socket.

With regards to the use of antibiotics to prevent dry socket development, penicillins and metrondizole were highly suggested in the literature.[22-23,39-40] The results of this study failed to show any significant effect of the preoperative antibiotic use on the incidence of dry socket. This, however, should also be considered inconclusive since antibiotics were not prescribed routinely even after surgical extractions and further investigation of this issue may be needed.

The clinical picture of dry socket in this study was comparable to generally described dry sockets in the literature. Pain and empty sockets were found in all patients, which is in agreement with the findings of several authors.[3,6,11,14,25] The average onset time of symptoms was around 36 hours after the extraction. This relatively early onset could be attributed to the co-existence of dry socket with other postoperative complications such as swelling and trismus since most cases followed surgical or difficult extractions. This is understandable when one considers the neurological pain of dry socket is believed to be related to the release of kinins, which are immediately available following tissue trauma. Cases in which the onset was a little more delayed can be explained by the notion that an infection process was needed to liberate tissue activators and pain mediators.[6]

Although exposed or bare bone has been reported as a possible clinical feature of dry socket, in this study bare bone was found in 75% of cases and was more frequent following simple than surgical extractions. It is possible, however, bare bone was present in some cases that followed surgical extractions but was obscured by the sutured flap over the socket orifice. In addition, halitosis was more frequently found in patients with poor oral hygiene, and this is not surprising since food impaction in the empty socket and its fermentation by bacteria is believed to be the cause of such a problem.[5]

As indicated by Fazakerley,[30] the primary aim of dry socket management is pain control until commencement of normal healing, and in the majority of cases local measures are satisfactory.

However, systemic analgesics or antibiotics may be necessary in some cases. In addition, the use of intra-alveolar dressing materials is widely suggested in the literature.[24,26,29]

In this study, the management protocol was similar to what is suggested in the literature and involved the traditional methods of normal saline irrigation , and placement of an Alvogyl® iodoform dressing (Septodont, Cambridge, ON, Canada) along with prescriptions of analgesics and systemic antibiotics for some patients. Dry socket patients were also instructed to return for follow up appointments during which the socket was examined, irrigated, and re-dressed.

Most patients returned for only one follow up visit during the same week which made the total treatment duration less than the 7-14 days recommended in the literature.[4,11,14,24-25] This could be attributed to more pain tolerance, self medication, seeking care from elsewhere, or a combination of these factors.

Conclusions

From the results of this study, the following conclusions can be made:

1. The overall prevalence of dry socket and its clinical picture at DTC/JUST was comparable to previous findings reported in the literature.
2. The prevalence of dry socket following single extractions was significantly higher than following multiple extractions.
3. The prevalence of dry socket was higher following surgical extractions than following non-surgical extractions.
4. There was a dose dependent relationship between smoking and the occurrence of dry sockets.
5. There was no statistically significant association between the development of dry socket and patient's age, sex, medical history, medications (preoperative or postoperative), indication for extraction, extraction site, operator's experience, and amount or technique of local anesthesia.

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