

Incidence of Dry Socket, Alveolar Infection, and Postoperative Pain Following the Extraction of Erupted Teeth

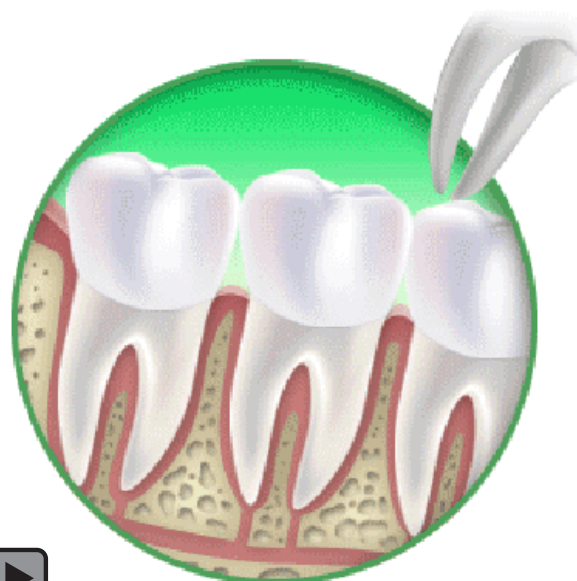
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Abstract

Aim: The aim of this study was to determine the incidence of dry socket, alveolar infection, and postoperative pain following the routine extraction of erupted teeth.

Methods and Materials: Using a questionnaire, this prospective cross-sectional study evaluated 357 consecutive surgeries in which 473 erupted teeth were extracted by dental students under rigorous control of microbiologic contaminants during a 22-month period. The subject sample consisted of 210 (58.8%) male patients ranging in age from 11 to 79 years (mean 41 ± 16.3). The most prevalent self-reported ethnicity was Caucasian (78.2%). The questionnaire consisted of 60 questions directed to the patient and to the dental student who performed the surgical procedure. The questionnaires were completed before and within seven days after the surgery to obtain outcomes data. Forty-five questionnaires were excluded due to lack of information, inconsistencies, or lack of contact with the patient; however, none had indications of alveolar infection or dry socket. The data were analyzed using descriptive statistics, chi-square tests (χ^2), and an odds ratio (OR) as appropriate at the critical level of significance, set at $p < 0.05$ (χ^2) or $p < 0.01$ (χ^2 , with the Monte Carlo simulation).

Results: The observed incidence was 0.6% (two cases each) for both alveolar infection and dry socket. Higher pain levels and pain persisting longer than two days were observed



with more traumatic surgeries, or associated with postoperative complications. Smoking was found to be statistically associated with the development of postoperative complications.

Conclusion: The incidence of alveolar infection, dry socket, and severe pain were very low for the routine extraction of erupted teeth. Severe pain that persists for more than two days can represent a sign of a postoperative complication such as dry socket.

Clinical Significance: Dental extraction is part of the dentists' daily work and intercurrents like dry socket, infection, and pain can occur.

This manuscript reports the incidence of these occurrences and search for its predisposing factors.

Keywords: Dry socket, dental infection, oral surgery, pain

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Introduction

Dry socket (DS) is an uncommon condition following the extraction of erupted teeth other than mandibular third molars. DS is the partial or total loss of the post-extraction blood clot, resulting in severe pain that usually starts one to five days postoperatively, with clinical evidence of exposed bone, necrotic debris, and halitosis.¹⁻⁵ Several other terms have been proposed for this condition such as fibrinolytic alveolitis, alveolar osteitis, localized osteomyelitis, postoperative alveolitis, and alveolitis sicca.¹⁻⁶

While the pathophysiology of DS remains unclear, the most accepted theory is the disintegration of the blood clot in the alveolus by increased fibrinolytic activity. While still a subject of controversy, the theoretical initiation of the fibrinolytic process has been reported to be related to multiple and probably interdependent factors such as the following:⁴⁻¹⁰

- Age
- Gender
- Use of oral contraceptives
- Smoking
- Duration of surgery
- Condition of the extracted teeth
- Degree of surgical trauma
- Menstrual cycle
- Presence of a preexisting infection or pericoronitis
- Inadequate irrigation or curettage of the socket after extraction
- Low operator experience
- Extraction of mandibular teeth
- Use of excessive amounts of local anesthetic with vasoconstrictor

The reported incidence of DS ranges from 1% to 45% and high scores are mainly related to the extraction of impacted third molars.^{1,8-12}

Oral surgeries are considered to be clean-contaminated procedures due to the presence of a rich oral microflora. This environment poses a risk for alveolar infection (AI) following single or multiple dental extractions even in healthy subjects, and when they occur repeatedly those are multimicrobial infections. Individuals at risk for a local or general infection also must be considered, such as patients who are immunodepressed, are malnourished, or have an uncontrolled associated systemic disease. The infection rate ranges from 2.7% to 4.4% following tooth extractions, with most infections being related to impacted third molar surgery.¹³⁻¹⁶

While a great deal has been published about third molar extractions, there are scarce data available related to DS and AI associated with routine erupted dental extraction in the recent literature.^{14,17} Pain that persists for more than two days can be a sign of postoperative complications that can result in clinical resources, operator time that increases costs and stress in a dental practice. Therefore, understanding the development of postoperative pain could be valuable to the clinician in terms of predicting and improving the treatment of these painful episodes.

The aim of this study was to determine the incidence of dry socket, alveolar infection, and postoperative pain following the routine extraction of erupted teeth in realistic clinical conditions using



favorable surgical techniques and to search for possible triggering factors for these conditions.

Methods and Materials

This is a prospective cross-sectional study to determine the incidence of pain, pain persisting longer than two days, dry socket, and alveolar infection following the extraction of erupted teeth. The study was carried out in the oral surgery clinics of the School of Dentistry at the Oeste de Santa Catarina University in Joaçaba, Santa Catarina, Brazil, under the supervision of an oral and maxillofacial surgeon. Using a questionnaire, the study evaluated 357 consecutive surgeries among 210 males (58.8%) and 147 females (41.2%) in an age range from 11 to 79 years (mean 41 ± 16.3). The most prevalent self-reported ethnicity among the study subjects was Caucasian (78.2%). A total of 473 erupted teeth were extracted from these subjects by dental students during a 22-month period between March 2007 and December 2008. The extractions were carried out under similar clinical conditions using rigorous infection control measures.

The questionnaire consisted of 60 questions directed to the patient and to the dental student who performed the surgical procedure. The questionnaires were completed before and within seven days after the surgery to obtain outcomes data. Forty-five questionnaires were excluded due to lack of information, inconsistencies, or inability to contact the patient. However, none had indications of alveolar infection or dry socket.

Outcomes information was obtained by telephone for the patients who were unable return at day seven. All procedures were performed under rigorous infection control measures. All dental handpieces, surgical drills, and instruments were sterilized in an autoclave and a sterile saline solution was used for the lavage of the alveolus and cooling of surgical burs when necessary.

Exclusion criteria included the extraction of third molars that were not fully erupted or classified as difficult for undergraduate dental students to remove and the extraction of deciduous teeth. The criteria for AI and DS were based on the clinical conditions as previously described by several authors.^{1,6,13,14,18} When present, those conditions were checked and confirmed by at least one of the

oral and maxillofacial surgeons of the research team. The clinical criteria for AI are as follows:

- Suppuration or intraoral abscess in the surgery site.
- Pain persisting or increasing 48 hours after surgery accompanied by intraoral inflammation (moderate or severe) and/or intraoral erythema (moderate or severe) with or without systemic fever.
- Persistent pain for no other justifiable reason that improves with antibiotic treatment.

The clinical criteria for DS are as follows:

- There is severe and persistent pain around the extraction site.
- There is a partially or totally disintegrated blood clot with exposed alveolar bone.
- Halitosis is usually present.

Dry socket is not characterized by redness, swelling, fever, or pus formation, opposing the characteristics of AI. All information concerning the patients' pain levels were self-reported and self-scored.

Analgesics were prescribed for all patients during the postoperative period, but nonsteroidal anti-inflammatory drugs (NSAIDs) were prescribed only to those patients when surgical trauma was considered extensive and a more painful postoperative episode was anticipated, as well as for patients who experienced a more painful outcome than expected. Steroidal anti-inflammatory drugs were not prescribed for any patient. Antibiotics were used under more specific conditions that included the following:

- Age greater than 65 years
- Immunocompromised patients
- Presence of a low red or white blood cell count
- Existent systemic diseases that implied a potential impairment of the healing process, or body defense capacity
- Surgery performed in areas classified as contaminated and infected
- Presence of an acute inflammatory process

The postoperative care and recommendations were similar for all patients and were directed primarily at keeping the blood clot in place. Post-surgical instruction included avoiding rigorous mouth rinsing, maintaining sensible oral hygiene, and achieving at least 12 hours of rest.

This study was submitted to the Ethical Committee for Human Research and informed consent was obtained from each patient.

Statistical Analysis

The data were analyzed using BioEstat, version 4, software (BioEstat, Belém, Pará, Brazil), and descriptive statistics, chi-square tests (χ^2), and odds ratio (OR) were used as appropriate at the critical level of significance, set at $p < 0.05$ (χ^2) or $p < 0.01$ (χ^2 , with the Monte Carlo simulation).

Results

This research evaluated 357 consecutive surgeries with 473 teeth extracted, and 45 questionnaires were excluded due to lack of information, inconsistencies, or lack of contact with the patient; however, none of those had indicated the presence of AI or DS. At least one systemic disease was identified in 19.3% (69) of the total sample population, including both male and female subjects. Hypertension (9.2%) was the most prevalent condition found, followed by diabetes (3.4%). Among the 147 female subjects (41.2%), 37 (25.2%) reported the use of oral contraceptives and six individuals (4.1%) reported menstrual bleeding in their monthly cycle on the day of their surgery. Smokers were 20.4% (73) of the sample; weekly alcohol consumption was declared by 18.8% (67) of the individuals; and weekly aate (Chimarrão, or *ilex paraguariensis*) tea consumption was declared by 64.7% (231) of the individuals.

The mean operating time for surgical procedures was 42 (± 28.2) minutes and single tooth extractions were performed in 74.2% (265) of the cases. A surgical flap was performed in 38.1% (136), osteotomy in 16% (57), and odontotomy in 14.3% (51) of the cases.

Local anesthetics containing 1:100,000 epinephrine were used for surgical procedures. In 180 cases (50.4%) 0.036 mg of epinephrine was used (two dental 1.8 ml anesthetic cartridges) and in 4.2% (15) of the total dental surgeries more than four cartridges (0.072 mg) of adrenalin were used.

Difficult surgeries were reported by 79 (22.1%) students; however, trans-surgical complications occurred in only 7% (25) of the cases, consisting

mainly of root and alveolar fractures, soft tissue lacerations, and oroantral communications. Acetaminophen was prescribed and used for 346 (96.9%) of the patients; 2 (0.6%) reported that they used another analgesic, while 9 (2.5%) patients reported that did not use any analgesic agent. Antibiotics were prescribed and used for 10.1% (36) and nonsteroidal anti-inflammatory drugs for 16% (57) of the patients.

Alveolar infection was detected in two cases (0.6%) involving females who were smokers. Daily tobacco consumption was statistically associated with AI ($p = 0.005$, χ^2 with Monte Carlo simulation—99%, 10,000 simulations).

DS was observed in two cases (0.6%) with one occurring in each sex (Figure 1). No systemic diseases or daily medicine consumption was reported for either case. Tobacco consumption was not statistically significant, although the smoking habit showed a high odds ratio (3.9 OR) for the development of DS with a confidence interval (CI) of 95%. The same occurred with regard to trans-surgical complications (OR 13.7; 95% CI). Odontotomy was performed in both cases and was statistically related with DS ($p = 0.001$, χ^2 with a Monte Carlo simulation—99%, 10,000 simulations).

Some variables of interest for AI and DS development can be viewed in Table 1.

In order to increase the power of the statistical analyses, DS and AI were considered to be postoperative complications (PC)



Figure 1. Clinical features of a dry socket.

Table 1. Variables studied and their relation to the development of alveolar infection (AI) and dry socket (DS).

Variables		Alveolar Infection (AI)			Odds Ratio (OR)	Dry Socket (DS)			Odds Ratio (OR)
		Yes	No	χ^2		Yes	No	χ^2	
Gender	Male	0	210			1	209		
	Female	2	145	NS	*	1	146	NS	1.4
Age	Up to 41 years (mean)	1	190			2	189	NS	*
	More than 41 years	1	165	NS	1.15	0	166		
Menstrual bleeding days (when applied)	Yes	0	6			0	6		
	No	2	139	NS	*	1	140	NS	*
Oral contraceptive (when applied)	Yes	0	37			1	36	NS	*
	No	2	108	NS	*	0	110		
Systemic disease	Yes	0	69			0	69		
	No	2	286	NS	*	2	286	NS	*
Tobacco consumption	Yes	2	71	$p=0.005$	*	1	72	NS	3.9
	No	0	284			1	283		
Alcohol consumption	Yes	0	67			0	67		
	No	2	288	NS	*	2	288	NS	*
Surgical flap (denuding bone)	Yes	0	136			1	135	NS	1.6
	No	2	219	NS	*	1	220		
Ostectomy	Yes	0	57			1	56	NS	5.3
	No	2	298	NS	*	1	299		
Odontotomy	Yes	0	51			2	49	$p=0.001$	*
	No	2	304	NS	*	0	306		
Report of difficult surgery	Yes	0	79			1	78	NS	3.5
	No	2	276	NS	*	1	277		
Periodontal disease present (mouth)	Yes	1	91	NS	2.9	0	92		
	No	1	264			2	263	NS	*
Oral hygiene	Fair	1	181			1	181		
	Poor	1	174	NS	1.04	1	174	NS	1.04
Small flaws in aseptic control	Yes	0	23			0	23		
	No	2	332	NS	*	2	332	NS	*
Postoperative antibiotic prescription	Yes	0	36	NS	*	1	35	NS	
	No	2	319			1	320	NS	
Evident purulent discharge at the surgical site	Yes	0	16			0	16		
	No	2	339	NS	*	2	339	NS	*
Trans-surgical complications	Yes	0	25			1	24	NS	13.7
	No	2	330	NS		1	331		
Adrenalin (1:100,000) in anesthetic solution	Up to 0.036 mg	1	179			1	179		
	More than 0.036 mg	1	176	NS	*	1	176	NS	*
Procedure time (mean)	Up to 42 minutes	1	209			1	209		
	More than 42 minutes	1	146	NS	1.43	1	146	NS	1.43
Legend: NS: Not statistically significant; * OR cannot be performed or not performed; χ^2 : Monte Carlo simulation, CI 99%.									

statistically associated with daily tobacco consumption ($p=0.007$, χ^2 using a Monte Carlo simulation—99%, 10,000 simulations; OR 12.1; 95% CI).

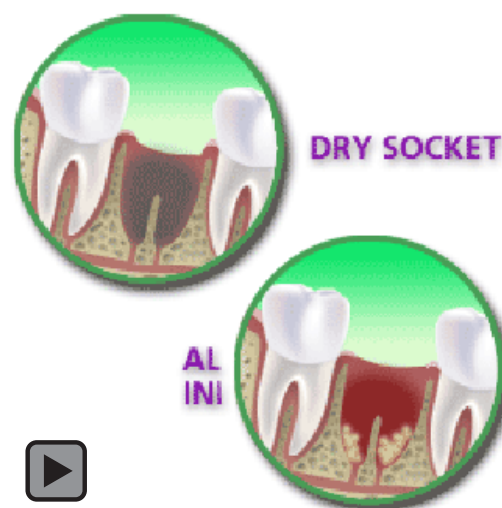
Pain was self-reported in 131 (36.7%) cases with levels described as low by 103 subjects (28.9%), moderate by 26 (7.3%), and severe by 2 (0.6%) with DS.

Pain that endured for more than two days was observed in 44 (12.3%) cases and was statistically associated with student reports of difficult surgeries ($p=0.015$, χ^2 test; OR 2.2; 95% CI), and for those surgeries in which more than one tooth was removed ($p=0.014$, χ^2 ; OR 2.2; 95% CI). A report of persistent pain of more than two days was associated with female patients who take daily contraceptive drugs ($p=0.027$, χ^2 ; OR 3.0; 95% CI). When pain levels were dichotomized and evaluated as low and moderate/severe, higher pain levels were observed in nonwhite patients ($p=0.007$, χ^2 ; OR 3.5; 95% CI), and when an osteotomy was performed ($p=0.002$, χ^2 ; OR 4.0; 95% CI) and when an odontotomy was performed ($p=0.03$, χ^2 ; OR 4.0; 95% CI).

Discussion

It is essential to establish a favorable standard of care to be used by clinicians during the extraction of teeth. The root of such a standard should be based on the principle that any surgical procedure no matter how small has at least some degree of risk of morbidity or mortality.^{19,20} This risk has to be managed appropriately using several strategies.

Risk management begins with a comprehensive evaluation of the physical and medical status of the patient. Routine blood tests (complete blood cell count, blood glucose, and any other tests indicated by an anamnesis) should be performed in order to identify several risk factors for PC in order to avoid them.^{10,21-23} Clinicians need to know and employ biosafety standards and aseptic procedures during any surgical procedure in order to minimize the risk of infection.²⁴ Proper planning for the procedure and use of an appropriate operating technique are essential to maximize the potential for a favorable surgical outcome. Favorable postoperative care and patient home



care instructions should be designed to maintain a good oral hygiene and preserve the alveolar blood clot following surgery. The present study utilized these principles with the belief that they represent good practices for extractions, which probably accounted for the incidence of DS and AI remaining below 1%.

In a recent published review article, Noroozi and Philbert¹⁰ reported that the majority of the literature supports the link between DS and surgical trauma, which was in agreement with the findings of the present study. Using sterile and clean, nonsterile gloves for nonsurgical dental extractions, Adeyemo¹⁴ found the incidence of healing complications to be dry socket at 8.6% and one alveolar infection at 9%. That study excluded third molar surgeries but raised some doubt concerning the concept of a “nonsurgical” dental extraction. There is also a question about the lack of information concerning the surgical trauma like that associated with osteotomy and odontotomy because it was unclear if these surgical complements were preformed. Oginni¹⁷ also reported an incidence of 4.1% of DS development after 3,319 dental extractions. The reasons for the incidence of DS being so high in Nigeria^{14,17} compared with Brazilian estimates could be related to economics, social and cultural influence on health problems, the principles of surgery utilized, or perhaps all of these factors.

There is some discussion and strong beliefs in the literature that the low experience of the operator could be a trigger for DS.^{14,17} However, in the present study, all procedures were conducted by undergraduate students; thus, low experience

itself was not related to DS or AI, but rather excessive trauma during the surgical procedure. It can be argued that excessive surgical trauma and low experience are related,^{5,25} however, this is not true for all cases. The reason is there are simple and sometimes difficult extractions with varying degrees of damage to adjacent tissues that may have little to do with operator experience.

Due to so few cases of DS and AI it was not possible to perform a more elaborate statistical analysis and interaction between the possible triggering factors for these outcomes in this study. A Monte Carlo simulation for the chi-square test was a mathematic option for the problem; however, it still indicates a probability for a single and isolated factor such as daily tobacco consumption and PC development. Habitual smoking has been found to be a contributing factor for PC, but almost all studies on this subject are related with third molar surgeries.^{5,10} Heng²⁶ assessed the contribution of habitual smoking to PC, such as pain, swelling, bleeding, and alveolar osteitis, and found it was related to an increase of these complications following extractions. Al-Belasy² also showed that the incidence of dry socket was higher among cigarette smokers than among nonsmokers (16% versus 7%) for third molar surgeries. Flynn²⁷ reported that 15 of 37 (41%) consecutive hospitalized patients with severe odontogenic infections were smokers, indicating that tobacco consumption also may have implications for the development of AI due to a possible relationship to a patient's state of health.

Pain persisting longer than two days, as well as higher pain levels, were found to be primarily associated with PC development and more surgical trauma (reports of difficult surgery, ostectomy, and odontotomy) in the present

study. These results are in accordance with the literature; however, those reports are mainly for third molar surgeries.^{28,29} Benediktsdóttir²⁸ implicated the extraction of teeth with curved roots as being more likely to cause high pain levels. This implies the use of ostectomy and odontotomy during these extractions, which is consistent with the findings of the present study. In addition, Baqain²⁹ reported that bone removal and tooth sectioning were risk factors for pain.

Conclusion

This prospective cross-sectional study of the observed incidence for AI and DS following the routine extraction of erupted teeth was 0.6% for each postoperative complication. Daily tobacco consumption was found to be associated with the development of AI and an odontotomy and trans-surgical complications were related with development of DS. Pain associated with the development of DS was self-reported in 36.7% of the cases, however, severe pain occurred only in 0.6% of the cases. Pain that persisted for more than two days was associated with difficult and more extensive surgeries with female patients who take daily contraceptives.

Clinical Significance

Dental extractions are a common procedure in a dental practice and may result in complications such as dry socket, alveolar infection, and postoperative pain. This study reveals the incidence of these conditions and examines the predisposing factors associated with the development of these postoperative complications.

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