



Extraction Wound Healing in Diabetic Patients in the Saudi Population

Mohammed Al-Ghamdi¹, Dr. Basem T Jamal², Razan Baabdullah³, Lina Mengari⁴

¹BDS, MSc (OMFS & Anesthesia), FRCD (C), Assistant Professor Oral & Maxillofacial Surgery, Faculty of Dentistry, King Abdul Aziz University, P.O. Box 20805, Jeddah, Saudi Arabia.

²ABOMS, Associate Professor Oral & Maxillofacial Surgery, Faculty of Dentistry, King Abdul Aziz University, P.O. Box 20805, Jeddah, Saudi Arabia.

³BDS, Faculty of Dentistry, King Abdul Aziz University, P.O. Box 20805, Jeddah, Saudi Arabia.

⁴BDS, Faculty of Dentistry, King Abdul Aziz University, P.O. Box 20805, Jeddah, Saudi Arabia.

myalghamdi@kau.edu.sa, bjamal@kau.edu.sa, rmsbaabdullah@kau.edu.sa, Lina.mengari@gmail.com

Abstract: Objectives: There is scarcity of data, in the literature, about wound healing of extraction socket in diabetic patients. This study aims at assessing wound healing and associated complications following exodontia and their relation to random blood glucose level and/or smoking in diabetic and non-diabetic patients in the Saudi population. **Subjects and Methods:** This prospective cross sectional study was based on 40 diabetic and 77 non-diabetic control patients, attending oral surgery clinics in King Abdulaziz University Dental Hospital, Jeddah. Wound healing of extraction sockets was assessed one-week postoperatively. Descriptive and bivariate statistics were computed at P-value 0.05. **Results:** Twenty-seven patients (29.3%) were diabetic and 65 patients non-diabetic while 25 patients were excluded. Females constituted the majority 67%, with a mean age of 39.5. Among ten smokers, four were diabetics, none had delayed healing events. Seven female patients non-diabetic patients had delayed healing beyond one week. No statistically significant difference were found between age, gender, blood glucose and smoking and wound healing. **Conclusion:** Although all of the events of delayed healing occurred in the non-diabetic control group, the difference was not statistically significant ($p = 0.076$). The association between smoking and diabetes in regard to delayed healing was not statistically significant ($p = 0.106$).

[Mohammed Al-Ghamdi, Dr. Basem T Jamal, Razan Baabdullah, Lina Mengar. **Extraction Wound Healing in Diabetic Patients in the Saudi Population.** *N Y Sci J* 2019;12(11):7-12]. ISSN 1554-0200 (print); ISSN 2375-723X (online). <http://www.sciencepub.net/newyork>. 2. doi:[10.7537/marsnys121119.02](https://doi.org/10.7537/marsnys121119.02).

Keywords: Post extraction wound, wound healing, diabetics, oral wounds and diabetes, extraction wounds and diabetes

1. Introduction

Diabetes and hyperglycemia-related factors have been linked to both acute and chronic impaired wound healing. A large body of evidence indicates that altered vascular, neuropathic, and immunological functions contribute to the altered wound healing process (1)(2)(3). In Saudi Arabia, as of 2011, 30% of 6024 subjects had type 2 diabetes(4).

Poor glycemic control increases the prevalence of microvascular and macrovascular complications. In an 11-year follow-up study, hypertriglyceridemia considered as a risk factor of coronary heart disease mortality in diabetic patients or patients with impaired glucose tolerance(5). Microvascular complications underlie much of the increased prevalence of diabetic retinopathy, diabetic nephropathy and diabetic neuropathy.

Hyperglycemia contributes to endothelial cell dysfunction, which in turn impairs angiogenic properties that's vital for tissue development and wound healing (5). Wound healing in diabetic patients

is defective because of the attenuation in immune cell response and impaired angiogenesis. The latter is directly proportional to the duration of diabetes(3).

In a study conducted by the Centers for Disease Control and Prevention (CDC), it was observed that poor glycemic control was most common among patients depending on insulin therapy alone or patients depending on insulin therapy and oral hypoglycemic. Diabetic patients who reported the use of oral medications only or no use of medications exhibited better glycemic control compared with those depending on insulin therapy alone or insulin therapy with oral hypoglycemic. Also, elderly aged ≥ 65 years were less likely to have poor glycemic control compared with adults aged 18-39 years(6).

In an experimental study on rats who were divided into 3 groups; rats with poor-controlled insulin-dependent diabetes mellitus, rats with well-controlled insulin-dependent diabetes mellitus, and a control group. Rats in the first group experienced a delay in wound healing following dental extraction

when compared to rats in the second and third groups (7).

While the literature clearly establishes that diabetics experience delayed healing of skin wounds, there is lack of data regarding wound healing status of intraoral wounds and extraction sockets in diabetics. At the time of publication of this paper, only two studies were conducted to assess the healing status following dental extractions. The first was a study conducted in the United States at 2010 and both types of diabetes were assessed in regard to healing status of extraction sockets but no control group was involved(8). The second study was conducted in 2013 and only patients with type 2 diabetes and on oral hypoglycemics were evaluated compared to a control group(9). Both studies found no difference in healing.

This study is aiming to assess and investigate the wound healing status following exodontia in diabetic patients compared to non-diabetic patients in the Saudi population and whether the difference in a random blood glucose level or smoking status is associated with certain wound healing complications.

2. Materials and Methods

This is a prospective study that was conducted in the oral surgery clinic at the Dental Hospital of King Abdul Aziz University, Jeddah, Saudi Arabia during the period from 2014 – 2015 academic year. Ethical approval was obtained from the Ethical Research Committee at the Faculty of Dentistry, King Abdul Aziz University.

One hundred and seventeen patients who needed an exodontia procedure were enrolled in the research project. Patients were then categorized into two groups; patients with history of any type of diabetes and a non-diabetic control group who have no conditions that affects or undermines healing. Exclusion criteria included conditions that may affect or impair wound healing such as immunodeficiency disorders, recent use of systemic steroids or antibiotics, bisphosphonate therapy, anticoagulant or antiplatelet therapy, chemotherapy, radiation therapy, systemic dental infection and oral and maxillofacial pathology.

Detailed medical history was registered using a questionnaire, which included demographics and medical history, current medications, history of smoking, onset of diabetes (in years), and treatment for diabetes. Preoperative random non-fasting blood glucose levels (BGL) were obtained and registered using a glucometer.

All patients underwent non-surgical extractions that was performed either an OMFS staff or in oral surgery teaching clinics under the supervision of one of the OMFS staff.

One-week follow-up was obtained by phone calls

and appointments were given when needed. Patients were asked about extraction socket status whether it is showing exposed bone or covered with tissues and infection signs including swelling, pus or fever. Furthermore, patients who experienced severe pain, halitosis, empty socket, bare bone and expected to have dry socket were instructed to attend for a follow-up appointment for proper management. Numerical pain rating scale was used as well for pain assessment.

Data were analyzed using IBM SPSS software, version 22.0. Analysis of multivariate regression was used. The healing status was compared between diabetic patients and the control group with regard to the preoperative BGL and medical condition as obtained using the questionnaire. Also, age, gender, smoking status and onset of diabetes were assessed whether they affect healing. Results were interpreted to be statistically significant if they have a P-value of less than 0.05.

3. Results

Of 117 patients, 8 patients were lost to follow-up and 1 patient was excluded because of her low random BGL that was 50 mg/dl and none of them were diabetic. Sixteen more patients were excluded because of the medications they were taking (antibiotics, analgesics, systemic steroids, anticoagulant, antiplatelet, radiotherapy, and chemotherapy), 13 of them were diabetics.

Of the remaining 92 patients, 27 were known type 2 diabetics on diet, oral hypoglycemic, insulin, or both; only one of them was a known type 1 diabetic as presented in Table 1. Sixty-five patients were in the non-diabetic control group. Of the patients, 82 had preoperative BGL of 180 mg/dl or less and 10 had BGL greater than 180 mg/dl (mean, 117.69 mg/dl; range, 57 -303 mg/dl). Eighteen of the diabetic group had a BGL of 180 mg/dl or less; the remaining nine patients had a BGL more than 180 mg/dl. All patients in the non-diabetic control group had a BGL of 180 mg/dl or less, only one of them had a BGL more than 180 mg/dl [Table 2].

Among 92 patients, 67% of them were females and the mean age of the patients was 39.45 years (range, 8-80 years). The age, gender, BGL, and smoking status in relation to delayed healing are presented in Table 1. Only ten patients were smokers (10.8%); four of them were diabetics. None of the ten smokers had delayed healing events. The association between smoking and diabetes in regard to delayed healing was not found to be statistically significant ($p = 0.106$). Only seven patients had healing delayed beyond one week as they were followed up clinically; all of them were females in the non-diabetic control group. Although all of the events of delayed healing occurred in the non-diabetic control group, the

difference was not statistically significant ($p = 0.076$). There were no cases of infection, osteomyelitis or osteonecrosis of the jaws. The diabetic group was older with more females and less smokers. They had no delayed healing events.

The relationship between delayed healing and preoperative random BGL is presented in Table 3. There was no statistically significant difference in assessment of delayed healing and other factors: age, gender ($p = 0.056$), smoking status ($p = 0.37$), and the presence of periapical pathology ($p = 0.457$), or preoperative infection ($p = 0.504$). Likewise, there was no significant difference between surgical and non-

surgical extraction in relation to healing status ($p = 0.088$). Closed exodontia was performed in all patients except in three patients where surgical extraction was indicated. Extraction was performed by OMFS staff, interns, and sixth and fifth year students as presented in Table 4. The events of delayed healing in relation to level of experience are also demonstrated in Table 5. Intraoperative complications occurred in 8 patients and are summarized in Table 6. These intraoperative complications did not affect healing status ($p = 0.585$). All events of postoperative complications occurred other than delayed healing are summarized in Table 7.

Table 1. Distribution (%) of diabetic patients according to diabetic medications

Medication	Number (%)
Diet only (no medications)	2 (2.2)
Oral hypoglycemics	16 (17.4)
Insulin	4 (4.3)
Oral hypoglycemics and insulin	5 (5.4)
Total	27 (100)

Table 2. Assessment of demographics in relation to healing status

Group	n	Age		Gender		BGL \leq 180		BGL $>$ 180		Smoker		Delayed healing	
		Mean	SD	n	%	n	%	n	%	n	%		
Non-diabetic	65	34	M	17	26.1	64	78	1	10	6	60	7	7
			F	48	73.8								
Diabetic	27	52	M	13	48.1	18	22	9	90	4	40	0	0
			F	14	51.8								

Table 3. Relationship between BGL and delayed healing

BGL	Diabetic	Non-diabetic	P-value
180 mg/dL or less	0 (0%)	6 (7.3%)	0.763
Greater than 180 mg/dL	0 (0%)	1 (10%)	

Table 4. Distribution (%) of operators who performed the extraction

Operator	Number (%)
Staff	5 (5.4)
Interns	17 (18.5)
Sixth year students	31 (33.7)
Fifth year students	39 (42.4)
Total	92 (100)

Table 5. Distribution (%) of operators who performed the extraction in relation to healing status

Operator	Healing Status		Total	P-Value
	Epithelialization	Delayed Healing		
Staff	5 (100)	0 (0.0)	5 (100)	0.111
Interns	17 (100)	0 (0.0)	17 (100)	
Sixth year students	30 (96.8)	1 (3.2)	31 (100)	
Fifth year students	33 (84.6)	6 (15.4)	39 (100)	
Total	85 (92.4)	7 (7.6)	92 (100)	

Table 6. Distribution of intraoperative complications

Intraoperative complications	Number
Oroantral communication	2
Tooth fracture	3
Buccal bone fracture	1
Presyncope	1
Tremor	1
Total	8

Table 7. Distribution of postoperative complications other than delayed healing

Event	Gender	Random BGL	Smoking status	Group
Numbness of the tongue	Female	95 mg/dl	Non-smoker	Non-diabetic
Trismus	Male	154 mg/dl	Non-smoker	Non-diabetic
Trismus	Female	110 mg/dl	Non-smoker	Non-diabetic
Sharp bone	Male	211 mg/dl	Non-smoker	Type 2 diabetes on insulin and oral hypoglycemic

4. Discussion

The prevalence of diabetes mellitus in Saudi Arabia has alarmingly worsened (10). The prevalence of diabetes mellitus in our study constitutes 29.3%, which is in accordance with a study conducted by Alqurashi et al in 2011 where 30% of 6024 subjects were found to have type 2 diabetes (4).

In the present study, 36% of the diabetic patients were diagnosed with diabetes since 2 – 5 years, 28% more than 10 years, 20% less than or equal to 1 year, and 16% since 6 – 10 years. However, since none of the diabetic patients had any event of delayed healing, diabetic duration appears to play an insignificant role in the healing of extraction socket. Nevertheless, diabetic duration was correlated with diabetic autonomic neuropathy. Longer duration of diabetes was found to be associated with more severe diabetic autonomic neuropathy (1).

Overall, only ten patients (10.8%) in this study were found to be smokers, which is lower than the recently reported figure of 37% for the adult Saudi population. In 2015, a review article regarding smoking prevalence in Saudi population was published concluding that the prevalence of smoking in Saudi Arabia has almost doubled from 21% in 1996 to 37% in 2012, especially in males (11). Although it is been reported that smoking is an important factor in delayed healing(12), none of the ten smokers had any event of delayed healing.

This study shows that although the clinical impression reflects that the non-diabetic patients had more events of delayed healing; the difference was not statistically significant between the diabetic group and the non-diabetic control group in healing of extraction socket ($p = 0.076$). This agrees with the findings of Aronovich et al. who studied both types of diabetes in regard to healing socket in 2010 and found that well-controlled and poorly controlled diabetic patients did not differ in healing outcome following exodontia (8).

In 2013, patients with type 2 diabetics on oral hypoglycaemics were compared to a control group and showed no statistically significant difference in post-extraction outcome (9).

However, in Peterson's Principles of Oral and Maxillofacial Surgery, it was stated, "Numerous studies have demonstrated that the higher incidence of wound infection associated with diabetes has less to do with the patient having diabetes and more to do with hyperglycemia."(13) It appears that this may be true in extraoral wounds only. The oral environment is different and according to this study and the previous two studies results suggest that there is no difference in wound healing of extraction sockets (8)(9).

Intra-oral healing of dental implant was assessed over a period of 3 years in type 2 diabetic patients. Probing depth, bleeding on probing and marginal bone loss were evaluated together with glycated hemoglobin A1c (HbA1c). It was found that pocket depths around the implants in relation to different readings of HbA1C were not statistically significant. Accordingly, they were not considered to be pathological. However, bleeding on probing was of statistical significance since an increased HbA1C played the major role. Marginal bone loss was increased in patients with increased levels of HbA1C. The authors concluded that patients with controlled diabetes can receive an implant therapy that is predictable (14).

The mechanism of post-extraction healing has been investigated in a diabetic rat model. In a group of Sprague-Dawley rats, insulin-dependent diabetes mellitus was induced by injecting streptozotocin. Another group was also injected with streptozotocin but diabetes was controlled by insulin injection daily. Rats in the control group were injected with citrate buffer. Rats then underwent extraction of the right upper molar teeth. The control group and the group controlled by daily insulin injection revealed thick

collagen fibers at the extraction socket site. However, rats in the uncontrolled insulin-dependent diabetic group revealed thin and insufficient collagen fibers at the extraction socket site resulting in delayed healing. None of the groups showed an evidence of diabetic microangiopathy in the extraction sockets (7).

Moreover, healing of extraction sockets following maxillary molar teeth extraction in the streptozotocin diabetic rat model treated with BMP-6 following extraction exhibited subperiosteal reaction in the extra-alveolar tissues and cartilage was formed(15).

Although oral and maxillofacial surgeons are obliged to take preoperative random BGL for diabetic patients before extraction, a random BGL of 200 or 300 mg/dl may not influence the decision to proceed with extraction in patient with severe pain as patient's diet may be affected and consequently, glycemic control. Some surgeons also believe that infection may predispose hyperglycemia and aggravate the condition. The decision to proceed with extraction in uncontrolled diabetic patients with high preoperative random BGL remains in the hands of the operating surgeon (8). In our study, 9 patients in the diabetic group were found to have a random BGL above 180 mg/dl. Yet, none of them had any adverse event related to healing. This brings us to question the benefit of obtaining preoperative random BGL measurements in diabetic individuals as the benefit of it is indistinct (8). The only patient in the control group who was found to have a random BGL above 180 mg/dl (195 mg/dl) stated that she was diagnosed with gestational diabetes when she was pregnant, but not anymore. However, she had a delayed healing event following extraction.

Extraction was performed by OMFS staff, interns and both fifth and sixth year students, only 2 patients had acute oroantral communication resulted from maxillary extractions and both were immediately closed by the OMFS staff without sequelae. The healing of both diabetic and non-diabetic control groups is independent of the operator as extractions were done randomly by a number of different operators ($p = 0.111$). The original plan for this study was that the diabetic group would be categorized into 2 distinct groups: patients with type 1 diabetes and patients with type 2 diabetes, but this did not eventuate since all the diabetic patients in this study were found to have type 2 diabetes except for one patient who was a known type 1 diabetic. Moreover, further similar studies are in demand to evaluate healing status following exodontia in diabetic patients and to see their parallance to current studies.

Conclusion

This prospective cross-sectional study showed no

statistically significant difference in post-extraction healing status between diabetic and non-diabetic control patients ($p = 0.076$). Therefore, special precautions and warnings regarding adverse events in diabetic patients should be further investigated. The association between smoking and diabetes in regard to delayed healing was not statistically significant ($p = 0.106$).

Conflict of interest: none to declare.

References

1. Kim, S. K., Lee, K. J., Hahm, J. R., Lee, S. M., Jung, T. S., Jung, J. H., Chung, S.I. (2012). Clinical significance of the presence of autonomic and vestibular dysfunction in diabetic patients with peripheral neuropathy. *Diabetes & metabolism journal*, 36(1), 64–69. doi:10.4093/dmj.2012.36.1.64.
2. Gopi Krishna Kolluru, G.P., Shyamal, C. B., Christopher G. K. (2012). “Endothelial Dysfunction and Diabetes: Effects on Angiogenesis, Vascular Remodeling, and Wound Healing,” *International Journal of Vascular Medicine*, Article ID 918267, 30 pages. <https://doi.org/10.1155/2012/918267>.
3. Waltenberger, J., Lange, J., Kranz, A. (2000). Vascular endothelial growth factor- A-induced chemotaxis of monocytes is attenuated in patients with diabetes mellitus: A potential predictor for the individual capacity to develop collaterals. *Circulation*, 102(2):185–190. doi:10.1161/01.cir.102.2.185.
4. Alqurashi, K.A., Aljabri, K.S., Bokhari, S.A. (2011). Prevalence of diabetes mellitus in a Saudi community. *Annals of Saudi Medicine*, 31(1):19-23. doi: 10.4103/0256-4947.75773.
5. Fontbonne, A., Eschwège, E., Cambien, F. et al. (1989). Hypertriglyceridaemia as a risk factor of coronary heart disease mortality in subjects with impaired glucose tolerance or diabetes. Results from the 11-year follow-up of the Paris Prospective Study. *Diabetologia*, 32(5):300-304. <https://doi.org/10.1007/BF00265546>.
6. Ali MK, McKeever Bullard K, Imperatore G, Barker L, Gregg EW. (2012). Centers for Disease Control and Prevention (CDC). Characteristics Associated with Poor Glycemic Control Among Adults with Self-Reported Diagnosed Diabetes — National Health and Nutrition Examination Survey, United States,2007–2010 *Morbidity and Mortality Weekly Report (MMWR)*, 61(02);32-37.
7. Devlin, H., Garland, H., Sloan, P. (1996). Healing of tooth extraction sockets in experimental diabetes mellitus. *Journal of Oral*

- and Maxillofacial Surgery*, 54(9):1087-1091. [https://doi.org/10.1016/S0278-2391\(96\)90166-4](https://doi.org/10.1016/S0278-2391(96)90166-4).
8. Aronovich, S., Skope, L.W., Kelly, J.P.W., Kyriakides, T.C. (2010). The relationship of glycemic control to the outcomes of dental extractions. *Journal of Oral and Maxillofacial Surgery*, 68(12):2955–2961. <https://doi.org/10.1016/j.joms.2010.05.006>.
 9. Huang, S., Dang, H., Huynh, W., Sambrook, P.J., Goss, A. N. (2013). The healing of dental extraction sockets in patients with Type 2 diabetes on oralhypoglycaemics: A prospective cohort. *Australian Dental Journal*, 58(1):89–93. <https://doi.org/10.1111/adj.12029>.
 10. Al-Daghri, N.M., Al-Attas, O.S., Alokail, M.S., Alkharfy, K.A., Yousef, M., Sabico, S.L., Chrousos, G. P. (2011). Diabetes mellitus type 2 and other chronic non- communicable diseases in the central region, Saudi Arabia (riyadh cohort 2): a decade of an epidemic. *BMC Medicine*, 9:76. <https://doi.org/10.1186/1741-7015-9-76>.
 11. Almutairi, K.M. (2015). Trends in Current Tobacco Use, Smoking Rates and Quit Attempts among Saudi Population during Periods of 17 Years (1996–2012): Narrative Review Article. *Iranian Journal of Public Health*, 44(2):170–175. (PMID:25905050 PMID:PMC4401874).
 12. Noroozi, A.R., Philbert, R.F. (2009). Modern concepts in understanding and management of the “dry socket” syndrome: comprehensive review of the literature. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics*, 107(1):30–35. <http://dx.doi.org/10.1016/j.tripleo.2008.05.043>.
 13. Miloro, M., Larsen, P.E., Ghali, G.E. and Waite, P.D. (2004) Peterson’s Principles of Oral and Maxillofacial Surgery. 2nd Ed., BC Decker, Hamilton, London. PMPH- USA; 2004 [cited 2015 May 1]. 1800 p. Available from: <https://books.google.com/books?id=Jf9WZltV1BAC&pgis=1>.
 14. Gómez-Moreno, G., Aguilar-Salvatierra, A., Rubio Roldán, J., Guardia, J., Gargallo, J. and Calvo-Guirado, J.L. (2015) Peri-Implant Evaluation in Type 2 Diabetes Mellitus Patients: A 3-Year Study. *Clinical Oral Implants Research*, 26, 1031-1035. <http://dx.doi.org/10.1111/clr.12391>.
 15. Shyng, Y.C., Chi, C.Y., Devlin, H., Sloan, P. (2010). Healing of tooth extraction sockets in the streptozotocin diabetic rat model: Induction of cartilage by BMP-6. *Growth Factors*, 28(6):447-51. DOI:10.3109/08977194.2010.527966.

10/29/2019