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REVIEW

ASSOCIATION BETWEEN HYPERGLYCEMIA AND POST-EXODONTIA COMPLICATIONS IN PATIENTS WITH TYPE II DIABETES MELLITUS: A SCOPING REVIEW

Asociación entre hiperglucemia y complicaciones post-exodoncia en pacientes con Diabetes Mellitus tipo II: Scoping Review

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a prevalent chronic metabolic disorder worldwide, with Type II DM (T2DM) emerging as the most widespread variant. In Chile, approximately 11% of adults aged 20 to 79 suffer from this condition. Given its high prevalence, dental surgeons should be trained to evaluate risk factors, particularly the potential complications linked to tooth extraction in individuals with T2DM.

Objetive: To describe the available scientific evidence on post-exodontia complications associated with hyperglycemia in patients with Type II diabetes mellitus.

Materials and Methods: An exploratory systematic review was conducted following the PRISMA-ScR extension protocols using the databases *PubMed, EBSCO, Scopus* and *the Cochrane Library*. The search employed the following algorithms: ((*"Diabetic patient complications"* AND *"dental extractions"*)), ((*"Diabetes"* AND *"tooth extraction"*)), ((*"Glycemia"* AND *"tooth extraction complications"*), ((*"Blood glucose"* AND *"tooth extractions"*), ((*"Dental extraction sockets"* AND *"diabetics"*).

Results: Out of a total of 973 articles, 25 were included for this review. Six relevance criteria were considered, revealing safety parameters for conducting extractions in patients with T2DM, with capillary blood glucose levels not exceeding 200 mg/dL for elective extractions and 240 mg/dL for emergency extractions.

Conclusions: There is limited evidence correlating threshold values of hyperglycemia with post-extraction complications in patients with T2DM. Most authors agree that the primary concern is not T2DM itself, but hyperglycemia. Furthermore, there is minimal consistency in the recommended care protocols for these patients.

Keywords: Diabetes mellitus; Tooth extraction; Complications post-exodontia; Surgery, oral; Hyperglycemia; Review.

RESUMEN

Introducción: La diabetes mellitus (DM) es un trastorno metabólico crónico. A nivel mundial, la DM tipo II (DM2) resulta ser la más frecuente. En Chile, un 11% de la población adulta entre los 20 y 79 años la padece. Su alta prevalencia, requiere de un cirujano dentista preparado para valorar los factores de riesgo, como las posibles complicaciones asociadas a la extracción dental en estos pacientes.

Objetivo: Describir la evidencia científica disponible sobre complicaciones post-exodoncia asociadas a hiperglicemia en pacientes con diabetes mellitus tipo II.

Materiales y Métodos: Se realizó una revisión sistemática exploratoria bajo los protocolos de extensión PRISMA-ScR utilizando las bases de datos, *PubMed, EBSCO, Scopus* y *Cochrane Library* con los algoritmos de búsqueda ((*"Diabetic patient complications"* AND *"Dental extractions"*)), ((*"Diabetes"* AND *"Tooth extraction"*)), ((*"Glycemia"* AND *"tooth extraction complications"*)), ((*"Blood glucose"* AND *"Tooth extractions"*)), ((*"Dental extraction sockets"* AND *"Diabetics"*)).

Resultado: De un total de 973 artículos se incluyeron 25 artículos para esta revisión. Se consideraron 6 criterios de pertinencia, los cuales mostraron parámetros de seguridad para realizar exodoncias, en pacientes con DM2, con la glucemia capilar no mayor a 200mg/dl en caso de ser electiva y 240 mg/dl en exodoncia de urgencias.

Conclusión: Existe poca evidencia que correlacione valores absolutos de hiperglucemia y complicaciones post exodoncia en pacientes con DM2. La mayoría de los autores concuerda en que el problema no es la DM2, sino la hiperglucemia. Existe poca uniformidad en los protocolos de atención recomendados para estos pacientes.

Palabras Clave: Diabetes mellitus; Extracción dental; complicaciones post-exodoncia; Cirugía bucal; Hiperglucemia; Revisión.

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INTRODUCTION

Oral pathologies are a serious public health concern due to their widespread prevalence in the population and the associated treatment costs.[1] Surgical extraction procedures are also frequently necessary for managing many oral pathologies.

In 2020, a study conducted in primary care facilities revealed that extractions accounted for 10.64% of all dental procedures among individuals aged 20 to 64 years and 15.78% among those aged 65 and older.[2]

Diabetes mellitus, according to the World Health Organization (WHO), is characterized as a chronic condition emerging from insufficient insulin secretion by the pancreas or ineffective utilization of the insulin produced by the body.[3] The American Diabetes Association (ADA) further categorizes diabetes into distinct types: T1DM (mar-ked by autoimmune degradation of pancreatic beta cells); T2DM (involving a gradual decline in insulin secretion often coupled with insulin resistance); other specific types originating from causes unrelated to T1DM and T2DM; and gestational DM.[4,5]

Approximately 1,372,700 individuals in Chile are affected by DM, constituting roughly 11% of the population aged between 20 and 79 years old.[5] A common and rapid technique to measure blood glucose levels is the *"Hemoglucotest"* (HGT), often administered in dental practice prior to treatment. Alterations from normal values are classified as states of hypo or hyperglycemia, with reference values being 125 mg/dL on an empty stomach and 180 mg/dL 2 hours postprandial.

Posible complications related to sustained hyperglycemia include diabetic ketoacidosis (DKA), primarily associated with T1DM, and hyperosmolar hyperglycemic state (HHS), commonly linked to T2DM.[6-9]

Hyperglycemia is associated with a higher rate of infections and disruptions in the healing process. Diabetic individuals exhibit alterations in the inflammatory response, microvascular dysfunction, and increased oxidative stress, all of which compromise metabolic flow to the tissues and con-sequently increase the risk of surgical procedure failure.[6,9,10] Currently, evidence is insufficient to describe complications associated with low and medium complexity extractions in diabetic patients.

In hyperglycemic patients, a greater risk of post-extraction complications is observed, with the most common being alveolitis, hemorrhages, infection of the surgical site and potential progression to abscesses, cellulitis, phlegmon, and, in more complex cases, mucormycosis.[11]
Current evidence suggests protocols regarding the care of diabetic patients or those in a state of hyperglycemia, considering the risk factors associated with this condition. The following question then arises: Is there a relationship between hyperglycemia and post-extraction complications in Type II Diabetes Mellitus?

General objective

- To describe the available scientific evidence on post-extraction complications associated with hyperglycemia in patients with Type II diabetes mellitus.

Specific objectives

- To reference the existence of preventive protocols for post-extraction complications in Type II diabetic patients with hyperglycemia.
- To propose a dental care protocol for Type II diabetic patients with an indication for extraction.

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MATERIALS AND METHODS

An exploratory systematic review or scoping review was conducted following the recommendations of the Joanna Briggs Institute, Systematic Reviews and Meta-analysis Protocols (PRISMA-ScR) for the planning and reporting of systematic exploratory literature reviews, updated to 2022.

The search strategy was independently carried out in English and Spanish by the researchers in parallel across the PubMed, EBSCO, Scopus, and Cochrane Library databases, with a maximum restriction of 5 years (Figure 1). Search terms in titles and abstracts included ((“Diabetic patient complications AND dental extractions”)), ((“Diabetes AND tooth extraction”)), ((“Glycemia AND dentistry”)), ((“Blood glucose AND tooth extractions”)), ((“Dental extraction sockets AND diabetics”)) combined using the Boolean operator “AND.”

Additionally, a manual search for potential additional articles was conducted by reviewing the reference lists of primary articles. The detailed search strategies are shown in Table 1.

Inclusion criteria

- Studies published between 2017 and 2022.
- Studies examining complications and parameters of dental care in patients with Type II diabetes.
- Studies including glycemic levels and post-exodontia complications among their variables.

Exclusion criteria

- Duplicate articles.
- Research not carried out on humans.
- Studies on diabetic patients other than Type II.

After removing duplicates, articles were selected based on their titles and abstracts. Subsequently, the full text of the remaining articles was read, and those that best met the selection criteria were chosen.

Data extraction was independently conducted by the researchers, who reviewed the results and compared them, ending in both quantitative and qualitative analyses. The PRISMA-ScR model was used for this purpose (Figure 1).

The bibliometric variables considered in this study included the geographical location where the studies were conducted, the year of publication, and the impact factor according to the Journal Citation Reports (JCR). These bibliometric variables are detailed in Table 2.

RESULTS

From the databases, a total of 2400 publications were identified. The initial removal of articles by year narrowed down the selection to those published between 2017 and 2022, resulting in 973 articles. Among these, 24 duplicates were discarded, while 70 were deemed ineligible by automation tools, and 325 for other reasons.

Additionally, 522 were removed as they were outside the focus of the review, leaving 32 publications for further evaluation of eligibility. Out of these, 12 were excluded, resulting in a total of 20 articles. Furthermore, 5 additional articles were included through other methods. Finally, the remaining articles were read and discussed, resulting in 25 articles being selected for the review. Six relevance criteria were considered for these 25 selected articles, as described in Table 3.

Of the 25 selected articles, 12 correspond to case-control studies, 3 to cohorts, and 10 to systematic reviews. Among the systematic re-

views and cohort studies, 5 do not specifically describe post-extraction complications but were relevant in updating the classification and care parameters of diabetic patients in general.

Figure 1. Methods flow chart of study protocol according to the extension for Scoping Reviews from the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines.

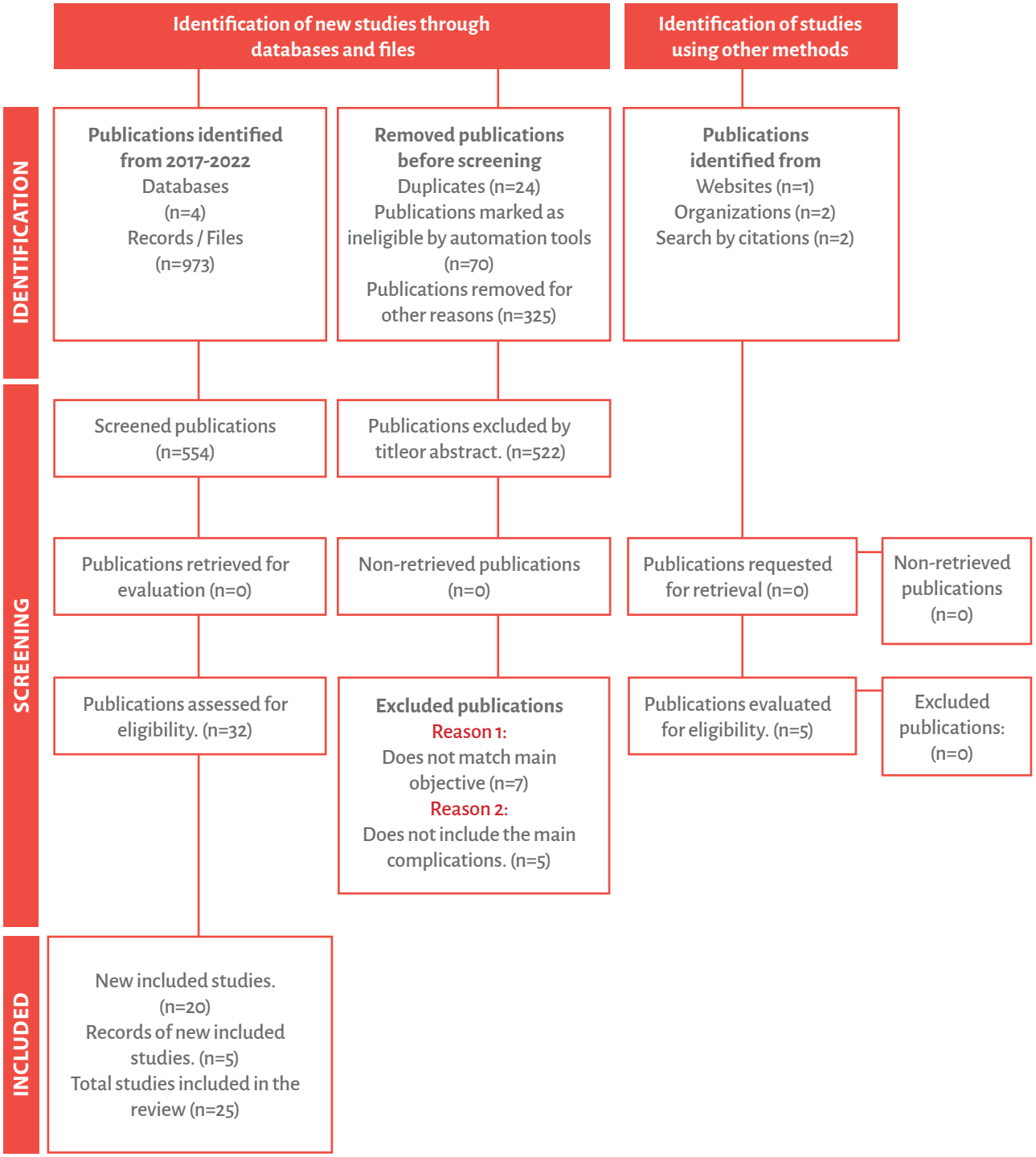

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Figure 2. Proposed dental care protocol for a diabetic patient requiring extraction.

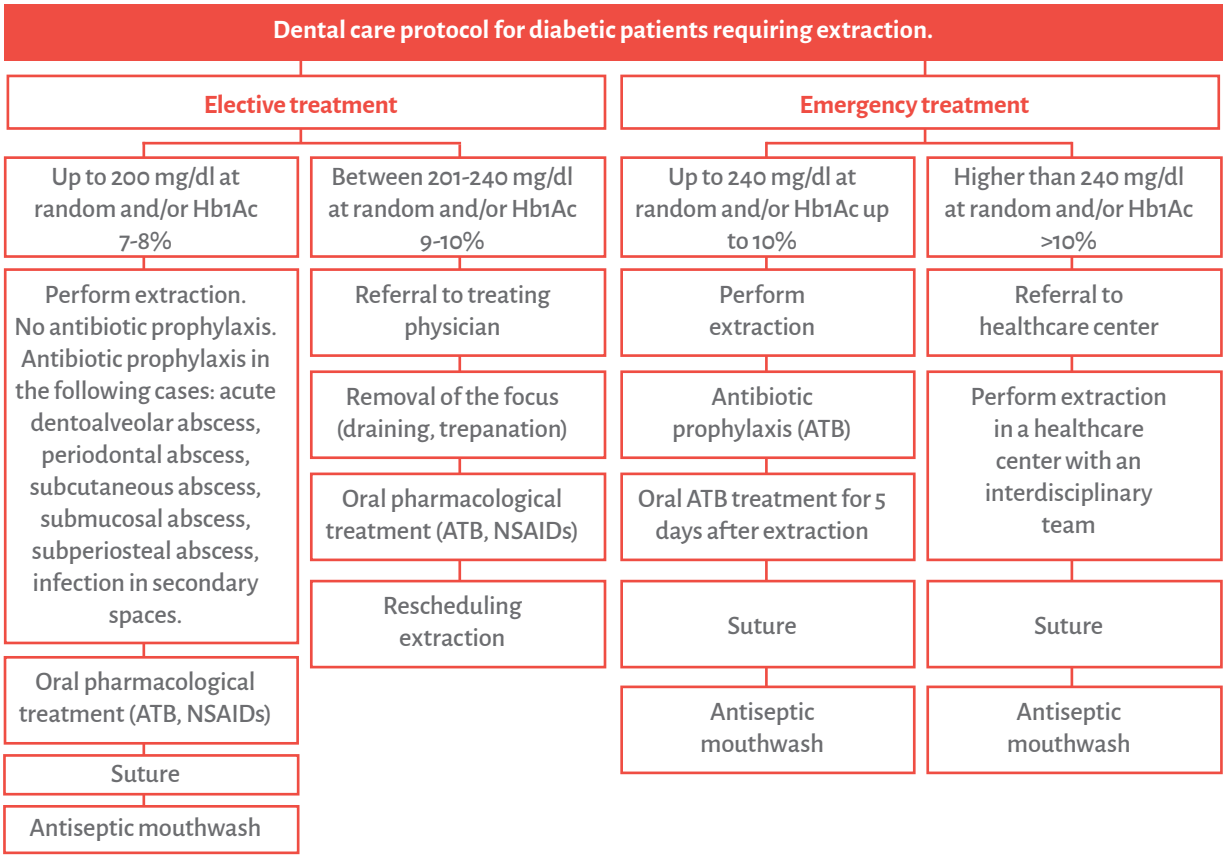

Table 1. Search strategies carried out in each search engine.

DATABASES	SEARCH	RESULTS
PUBMED	#1 (diabetic patient complications) [MeSH Terms]) AND (dental extractions) [MeSH Terms]	127
	#2 (Diabetes [MeSH Terms]) AND (tooth extraction [MeSH Terms])	175
	#3 Glycemia AND tooth extraction complications	23
	#4 (Blood glucose [MeSH Terms]) AND (tooth extractions [MeSH Terms])	40
	#5 Dental extraction sockets AND diabetics	58
EBSCO	#1 Diabetic patient complications AND dental extractions	4
	#2 Diabetes AND tooth extraction	894
	#3 Glycemia AND tooth extraction complications	2
	#4 Blood glucose AND tooth extractions	153
	#5 Dental extraction sockets AND diabetics	2
SCOPUS	#1 TITLE-ABS-KEY (Diabetic patient complications AND dental extractions)	52
	#2 TITLE-ABS-KEY (Diabetes AND tooth extraction)	662
	#3 TITLE-ABS-KEY (Glycemia AND tooth extraction complications)	1
	#4 TITLE-ABS-KEY (Blood glucose AND tooth extractions)	168
	#5 TITLE-ABS-KEY (Dental extraction sockets AND diabetics)	26
COCHRANE LIBRARY	#1 Diabetic patient complications AND dental extractions	3
	#2 Diabetes AND tooth extraction	5
	#3 Glycemia AND tooth extraction complications	0
	#4 Blood glucose AND tooth extractions	1
	#5 Dental extraction sockets AND diabetics	1

Table 2. Bibliometric variables of the sources used in this study.

SEARCH PLATFORM	IMPACT FACTOR (JCR)	JOURNALS	YEAR OF PUBLICATION	GEOGRAPHIC LOCATION	LANGUAGE
PUBMED EBSCO SCOPUS COCHRANE LIBRARY	Mean impact factor: 4.96 Highest: 19.11 Lowest: 0	Saudi Dent. J. Aust Dent. Saudi Med. J Oral Maxillofac Pathol Int.I J. Dent Scie. J Arthroplasty. Exp Biol Med (Maywood). Clin. Oral. Investig. Quintessence Int. Int Endod J. Clinical and Exp. D. R. Diabetes Care. Rev. Asoc. Odont. Argent. Clin. Cosmetic and Invest. Dentistry.	2017-2020	China Chile Saudi Arabia India United States Norway Colombia Australia Pakistan Romania Brazil Serbia Germany Bahrain Switzerland Iran	English Spanish Chinese

Table 3. Variables associated with specific objectives extracted from the identified papers .

Author	Values for performing extraction with DM	Complications associated with DM	Includes protocol for DM	Hb1Ac	Extraction with hyper-glycemia	Poor socket healing
Agani *et al.*[29]	✓	✓	✓		✓	✓
Aishwarya *et al.*[14]	✓	✓			✓	✓
ElSayed *et al.*[36]		✓		✓		
ElSayed *et al.*[35]		✓		✓		
Dhanavelu *et al.*[13]		✓	✓		✓	✓
Ghadi *et al.*[12]	✓	✓	✓	✓	✓	
Ghadi *et al.*[16]	✓	✓				
Gadicherla *et al.*[25]		✓		✓	✓	✓
Gazal *et al.*[7]	✓	✓	✓	✓	✓	✓
Gupta *et al.*[15]	✓	✓	✓		✓	✓
Håheim *et al.*[34]		✓				✓
Hoyos *et al.*[28]		✓		✓		✓
Kang *et al.*[20]		✓				✓
Krishnan *et al.*[18]	✓	✓	✓	✓	✓	
Maftei *et al.*[22]		✓		✓		✓
Muzaffar *et al.*[33]	✓	✓		✓	✓	✓
Okonkwo *et al.*[19]		✓				✓
Piedades *et al.*[32]		✓			✓	✓
Power *et al.*[24]		✓			✓	✓
Prabhu *et al.*[17]		✓				✓
Radovc *et al.*[23]		✓		✓	✓	✓
Rajashri *et al.*[11]		✓	✓			
Sambrook *et al.*[31]		✓	✓			✓
Shakeel *et al.*[26]		✓				
Wang *et al.*[27]	✓	✓	✓	✓	✓	

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Table 4. Summary of main results of the selected articles.

AUTHOR	TITLE	TYPE OF STUDY	YEAR	SUMMARY
Agani *et al.*[29]	The changes in levels of blood cortisol, glucose, and oxygen saturation in type 2 diabetic patients during tooth extraction.	Cases and controls.	2022	Evaluation of cortisol, glucose and oxygen saturation levels post extraction in diabetic patients. It is indicated that treatment causes an increase in blood glucose and blood pressure. Greater risk of post-exodontia complications.
Aishwarya *et al.*[14]	Comparison of Post Extraction Healing in Diabetic Patients with two different Blood Glucose Levels - A Case Control Study.	Cases and controls	2021	Study in diabetic patients in which there is a significant difference in healing after extraction when blood glucose is greater than 200 mg/dl. Every 1% decrease in the HbA1c level leads to a 37% reduction in microvascular complications.
ElSayed *et al.*[36]	Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes.	Systematic review	2022	It is recommended to evaluate glycemic control in diabetic patients using glycosylated hemoglobin (A1C) due to its greater predictive value for diabetes complications. Lower A1C levels were associated with reduced onset or progression of some microvascular complications.
ElSayed *et al.*[35]	Glycemic Targets: Standards of Medical Care in Diabetes.	Systematic review	2022	Fasting glycemic control in conjunction with glycosylated hemoglobin. High predictive value of complications in diabetic patients.
Dhanavelu *et al.*[13]	Diabetes mellitus and extraction.	Systematic review	2019	The procedures can be performed with the glucose level controlled with hyperglycemic medications and insulin. Adequate perioperative antibiotic coverage before and after extraction
Fonseca *et al.*[12]	Manejo odontológico del paciente diabético. Revisión narrativa. (Dental management of diabetic patients. A narrative review).	Systematic review	2021	Significant relationship between postoperative infection and blood glucose levels. It suggests a dental management protocol that considers current values of venous glycemia and HbA1c, medications, comorbidities and whether the patient suffers from consequences of macro- and microngiopathies.
Ghadi *et al.*[16]	Fulminant mucormycosis of maxillary sinuses after dental extraction in patients with uncontrolled diabetic: Two case reports.	Cases and controls	2018	Uncontrolled diabetic patients led to an infectious process: mucormycosis. The uncontrolled diabetic patient is immunocompromised.
Gadicherla *et al.*[25]	Comparison of Extraction Socket Healing in Non-Diabetic, Prediabetic, and Type 2 Diabetic Patients.	Cohort	2020	Delayed healing of the socket in diabetic patients on day 7 after extraction
Gazal *et al.*[7]	Management of an emergency tooth extraction in diabetic patients on the dental chair.	Systematic review	2019	Glycaemia up to < 180 mg/dl on an empty stomach and < 234 mg/dl at random as cut-off points for an extraction, due to the risk of infection and slow healing in wounds at higher levels.

Continuation Table 4. Summary of main results of the selected articles.

AUTHOR	TITLE	TYPE OF STUDY	YEAR	SUMMARY
Gupta *et al.*[15]	Assessment of post operative wound healing in diabetic patients after extraction.	Systematic review	2017	Little clinical evidence of infections that occur after extraction. The most common complications over 250 mg/dl postprandial were dry socket and delayed healing.
Håheim *et al.*[34]	The Predictive Role of Tooth Extractions, Oral Infections, and hs-C-Reactive Protein for Mortality in Individuals with and without Diabetes: A Prospective Cohort Study of a 12 1/2-Year Follow-Up.	Cohort	2017	Missing teeth are a predictor of mortality along with hs-CRP and diabetes due to vulnerability to infections and inflammation. Infection and inflammation are associated with mortality in both people with diabetes and those without diabetes.
Hoyos *et al.*[28]	Factores fisiopatológicos y metas terapéuticas perioperatorias que influyen en procedimientos quirúrgicos reconstructivos mediante colgajos en pacientes con Diabetes Mellitus. (Pathophysiological factors and perioperative therapeutic goals that influence reconstructive surgical procedures using flaps in patients with Diabetes Mellitus)	Systematic review	2017	Associates hyperglycemia with a higher rate of infections and alterations in the healing process, specifically in the inflammatory response, microvascular dysfunction, and greater oxidative stress. Peri- and post-operative glycemic control significantly reduces the rate of complications, becoming comparable to that of non-diabetics. HbA1c reflects long-term changes and allows predicting the presence of micro and microvascular complications associated with DM, which are of great importance in the prognosis of surgery.
Kang *et al.*[20]	Diabetic wound healing in soft and hard oral tissues	Systematic review	2021	It defines diabetes as a metabolic disorder that alters function and healing responses, through delayed healing and elevation of proinflammatory cytokines.
Krishnan *et al.*[18]	Do preoperative glycosylated hemoglobin (HbA1C) and random blood glucose levels predict wound healing complications following exodontia in type 2 diabetes mellitus patients?	Cohort	2020	It seeks to analyze preoperative HbA1c and RGB tests to predict the risk of wound healing and infectious complications in patients with type 2 DM undergoing extraction. There is a slight increase in complications in diabetic patients, compared to control patients.
Maftei *et al.*[22]	Correlations between Salivary Immuno-Biochemical Markers and HbA1c in Type 2 Diabetes Subjects before and after Dental Extraction.	Cases and controls	2021	It correlates several markers of the oxidative state and proinflammatory biomarkers modified in the saliva of diabetic patients and is related to HbA1c levels, making them potential indicators of the healing state after extraction.
Muzaffar *et al.*[33]	Comparison of post-tooth extraction Wound healing in Patients with Optimal Diabetes control and Poor Diabetes control.	Cases and controls	2020	There is no significant evidence of delayed healing in decompensated and compensated diabetic patients, therefore, glycemic control does not influence post-exodontia healing in diabetics.
Okonkwo *et al.*[19]	Diabetes and wound angiogenesis.	Systematic review	2017	Poor healing in diabetic patients, relates to deficient vascular networks that lead to an alteration in all stages of healing.

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Continuation Table 4. Summary of main results of the selected articles.

AUTHOR	TITLE	TYPE OF STUDY	YEAR	SUMMARY
Piedades *et al.*[32]	Surgical complications in systemically compromised patients: analysis of 992 medical records.	Cases and controls	2020	Study that analyzed medical records of patients undergoing dental extractions between 2010 and 2015. Diabetes is the third most prevalent systemic change (11%), the sixth in alterations that produce postoperative complications, and its most associated complication is alveolitis (50%), followed by bone exposure (20%).
Power *et al.*[24]	The healing of dental extraction sockets in insulin-dependent diabetic patients: a prospective controlled observational study.	Cases and controls	2018	There is no statistically significant difference in healing after extraction between insulin-dependent diabetic patients and non-diabetics. A higher incidence of delayed healing is clinically observed in insulin-dependent patients. Controlled diabetic patients do not present changes in the healing rate of the socket.
Prabhu *et al.*[17]	A fatal case of rhinocerebral mucormycosis of the jaw after dentalextractions and review of literature.	Cases and controls	2017	Second case to date of rhinocerebral infection in a 70-year-old uncontrolled diabetic patient after an extraction. The patient died 10 days after surgical debridement and multidisciplinary approach.
Radovć *et al.*[23]	Salivary VEGF and post-extraction wound healing in type 2 diabetic immediate denture wearers	Cases and controls	2021	Delayed socket closure in diabetic patients. The main complications were gingival necrosis, ulcers, and pain. The presence of VEGF in saliva (increased in diabetic patients) would be a factor that contributes to faster wound healing. It may mitigate the detrimental effects of diabetes on healing.
Rajashri *et al.*[11]	Mucormycosis following tooth extraction in a diabetic patient: a case report.	Cases and controls	2020	55% of mucormycosis infections have diabetes as a predisposing factor. Special planning is suggested for these patients if an extraction must be performed.
Sambrook *et al.*[31]	Contemporary exodontia.	Systematic review	2017	Controlled type 2 diabetic patients can receive the same treatment as non-diabetic patients.
Shakeel *et al.*[26]	Pattern of tooth extraction in a Tertiary Care Hospital-Karachi, Pakistan.	Cases and controls	2020	Diabetes and smoking are considered significant risk factors for extractions.
Wang *et al.*[27]	Correlation analysis of preoperative glucose control targets and tooth extraction prognosis in elderly diabetic patients.	Cases and controls	2021	There were no significant differences in wound healing between the two dental extraction groups. Maximum acceptable reference value of fasting blood glucose of 10.00 mmol/l and HbA1c 8.5% before elective extraction.

DISCUSSION

Regarding the criterion of "values for performing the extraction," 36% of studies reported specific parameters of capillary glycemia, recommending levels not exceeding 200 mg/dL for scheduled extractions and 240 mg/dL in emergencies. Furthermore, in 44% of the total reviewed research, HbA1c was correlated as a factor to be considered in the decision-making process for performing extractions in patients presenting hyperglycemia during dental consultations.

In all selected studies, emphasis was placed on specifying post-extraction complications in diabetic patients. Regarding poor socket healing, discrepancies exist between systematic reviews and some case-control studies. Approximately 64% of studies described poor socket healing, regardless of the degree of severity, while the remaining authors either did not observe it or deemed evidence insufficient to support its occurrence.

The risk of infection is associated with hyperglycemia, particularly prevalent in patients with uncontrolled T2DM. Among the main components affecting such patients, we find advanced glycation end-products (AGEs). AGEs can alter immune system cells, thereby affecting their defensive capabilities. Furthermore, the increased production of IL-1, IL-6, tumor necrosis factor, may contribute to increased susceptibility to infections.[13]

Fasting hyperglycemia exceeding 240 mg/dL results in a high rate of adipose tissue metabolism, converting fatty acids into ketones. Elevated levels of ketones lower blood pH, interfering with healing by inhibiting macrophage activity and the secretion of nitric oxide. This creates a favorable environment for infections, pain, inflammation, alveolitis, or, ultimately, as reported by Ghadi *et al.,*[16] mucormycosis of the maxillary sinus.[14-17]

A study conducted by Krishnan *et al.,*[18] noted a higher incidence of infectious complications at a clinical level. However, their analysis of random blood glucose (RBG) and HbA1c values did not directly correlate with these complications, indicating the necessity for individual patient assessment. This highlights the importance of raising awareness about potential postoperative effects associated with a patient's diabetic condition.

Causes of delayed healing of the post-extraction socket in uncontrolled Type 2 diabetic patients

When tissue injury occurs, it results in a hypoxic state, disrupting the balance between vessel proliferation, maturation, and vessel inactivity.[19, 20]

Constant hyperglycemia disrupts tissue regeneration and the restoration of a healthy vascular system. T2DM has been implicated in the progression of vascular disease. Elevated systemic glucose levels in diabetic patients are the primary cause of numerous complications that can affect angiogenesis.[19]

Aishwayra *et al.,*[14] demonstrated that diabetic patients with a RBG level below 200 mg/dL prior to extraction had better quality healing and a shorter healing time compared to patients with RBG levels above 200 mg/dL. Rela *et al.,*[21] research indicates that patients with blood glucose levels around 250 mg/dL may experience inflammation and a burning sensation around the area of the extracted tooth.

At the oral level, patients with uncontrolled T2DM exhibit evident physiological changes. Maftei *et al.,*[22] when comparing molecules in saliva, such as TNF-α, found significantly higher values in patients with T2DM. This leads to alterations in vascular permeability,

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resulting in excessive edema after tooth extraction and delaying alveolar healing.Kang *et al.,*[20] discuss physiological changes in patients with hyperglycemia, noting a disruption in the healing rate due to reduced migration of keratinocytes and decreased production of growth factors. Furthermore, they suggest that persistent in-flammation negatively impacts gingival fibro-blasts, endothelial cells, and leukocytes.

Interleukin-18 (IL-18), responsible for regulating both the innate and adaptive immune response, shows significantly higher levels in patients with T2DM before and after extraction, unlike healthy individuals whose values were not significant.[22] This confirms the increase in inflammatory load in patients with DM.[22] However, these effects may be mitigated by vascular endothelial growth factor (VEGF) present in saliva.

This could explain why Power *et al.,*[24] found no statistically significant difference between patients with controlled T2DM and non-diabetic individuals, despite a higher incidence of delayed healing in hyperglycemic patients.[23,25]

Standards of dental care in diabetic patients with hyperglycemia

The random blood glucose test is used to verify blood glucose levels, with the Hemoglucotest being one of the most convenient and inexpensive methods to detect hyperglycemia.[12,18] Similarly, the HbA1c test complements the patient's blood analysis by offering advantages such as insensitivity to stress. Additionally, it assists in providing a prognosis of post-extraction complications by showing the patient's diabetes management and average glucose level over the past 2 to 3 months.

However, these tests are more expensive and may exhibit incomplete correlation in certain individuals.[27]

In postoperative management, after performing an extraction in a patient with hyperglycemia, it is suggested to complement the procedure with sutures that stabilize the tissue and control the hemostasis of the socket.[13, 28]

Treatment decision regarding elective or emergency extraction

There is a consensus among dentists regarding the importance of assessing patients' control over their blood glucose levels.[29,30] Furthermore, extractions may serve as stress inducers, triggering the production of catabolic hormones and leading to elevated blood glucose levels. [13,24]

In elective extractions, patients with a random hyperglycemia of up to 200 mg/dL and/or HbA1c levels between 7% - 8% may undergo the procedure without requiring subsequent prophylaxis or antibiotic treatment. However, for patients with odontogenic infection associated with the tooth to be extracted, it is recommended to supplement the procedure with prophylaxis and antibiotic therapy.[29]

For all cases where extraction is performed, it is advisable to implement hemostatic measures. Moreover, the use of antiseptic mouthwash is recommended to prevent post-extraction infection.[7]

In cases of patients scheduled for elective extraction, if their RBG level ranges from 201 mg/dL to 240 mg/dL and/or HbA1c is between 9-10%, it is recommended to reschedule the extraction and refer the patient to their treating physician for compensation. In the case of pain and/or infection, the focus should be eliminated through drainage or trepanation, and oral pharmacological treatment with antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) should be prescribed to manage the symptoms.[12]

In the event of an emergency extraction, if RBG values are up to 240 mg/dL and/or HbA1c is

up to 10%, it is suggested to proceed with the extraction, following by suturing, and prescribing antibiotic prophylaxis and treatment for five days. Additionally, mouthwash with oral antiseptic should be recommended. If the patient's blood glucose level exceeds 240 mg/dL in RBG and/or HbA1c is >10%, it is necessary to refer them to a healthcare center to perform the extraction.[13,31]

Protocols for performing extraction in diabetic patients with hyperglycemia

As reviewed, the absence of literature detailing a protocol for dental care in managing extractions in decompensated or poorly controlled diabetic patients during hyperglycemic episodes is recognized as a challenge.

Within this context, all authors agree on the importance of a correct anamnesis, and 52% of them advocate for performing extractions in hyperglycemic diabetic patients following a care protocol. Ideally, this procedure should be conducted in the mornings, with antibiotic prophylaxis administered to decompensated patients, and comprehensive follow-up care provided.

CONCLUSION

Among the available articles, it was evident that RBG and HbA1c tests have been widely used to assess the glycemic status of patients. The correlation between hyperglycemia and the risk of associated complications becomes evident when diabetic patients are not properly controlled. However, despite clinical trials indicating values exceeding 200 mg/dL, there is no direct suggestion of a relationship between hyperglycemia and post-exodontia complications in patients with T2DM. The primary post-extraction complications in these patients are associated with micro-vascular alterations and delayed healing, which could consequently lead to infection in the alveolus and, eventually, in the adjacent tissues. Although there are only few reported cases, post-extraction mucormycosis may also occur.

While there is no consensus among the reviewed articles regarding the definition of protocols for the care of patients who require extraction while in a state of hyperglycemia, a glycemia range of 200 mg/dL for RBG has been established as the initial cutoff point for elective tooth extraction, and 240 mg/dL for RBG when it is an emergency extraction.

A proposed protocol has been developed for evaluating extraction in a patient with T2DM experiencing hyperglycemia during the extraction procedure (Figure 2). Initially, it is recommended to determine whether it is an elective or emergency extraction. Furthermore, it is essential to measure the patient's blood glucose using RBG and/or Hb1Ac before the procedure. Once these parameters are obtained, clinical decisions can be made to prioritize the patient's systemic well-being. Among the recommendations provided, the authors suggest using a 0.12% chlorhexidine mouthwash. During suturing, it is advisable to avoid materials that promote the retention of food debris and to emphasize the importance of post-extraction follow-up within the specified time frames for suture removal.

Among the studies analyzed, there is a lack of consistency in criteria concerning the correlation between tooth extraction and blood glucose levels in patients with T2DM. Nonetheless, most studies agree that the primary concern is not T2DM itself, but hyperglycemia. Further clinical studies are recommended to assess whether specific blood glucose thresholds are associated with post-extraction complications.

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AUTHORS' CONTRIBUTIONS

Olivares I: Conceptualization, Formal Analysis, Methodology, Supervision.

Aróstica V: Investigation, Methodology, Resources, Software, Writing – Original Draft.

Estay A: Investigation, Methodology, Resources, Software, Writing – Original Draft.

Quitral R: Methodology, Supervision, Writing – Review and Editing.

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REFERENCES.

1. Ministerio de Salud. "PLAN NACIONAL DE SALUD BUCAL 2021 – 2030". 2021.Avalaible at: https://www.minsal.cl/wp-content/uploads/2022/02/PLAN-NACIONAL-DE-SALUD-BUCAL-2021-2030.pdf

2. Moraga L. Tendencia de actividades odontológicas realizadas enatención primaria del servicio de salud Valparaíso -San Antonio, CHILE: 2008 A 2018. Rev. Chil. Salud Pública. 2020;24(2):104–14.

3. Keays R. Diabetes. Curr Anaesth Crit Care. 2007; 18(2):69–75

4. Care D, Suppl SS. Classification and Diagnosis of Diabetes : Standards of Medical Care in Diabetes — 2022. Diabetes Care. 2022;45(Suppl):17–38.

5. Mayer-Davis EJ, Kahkoska AR, Jefferies C, Dabelea D, Balde N, Gong CX, Aschner P, Craig ME. ISPAD Clinical Practice Consensus Guidelines 2018: Definition, epidemiology, and classification of diabetes in children and adolescents. Pediatr Diabetes. 2018;19 Suppl 27(Suppl 27):7-19. doi: 10.1111/pedi.12773. PMID: 30226024; PMCID: PMC7521365.

6. Poudel P, Griffiths R, Wong VW, Arora A, Flack JR, Khoo CL, George A. Perceptions and practices of general practitioners on providing oral health care to people with diabetes - a qualitative study. BMC Fam Pract. 2020;21(1):34. doi: 10.1186/s12875-020-1102-9. PMID: 32054440; PMCID: PMC7020546.

7. Gazal G. Management of an emergency tooth extraction in diabetic patients on the dental chair. Saudi Dent J. 2020;32(1):1-6. doi: 10.1016/j.sdentj.2019.07.004. Epub 2019 Aug 5. PMID: 31920272; PMCID: PMC6950840.

8. Tourkmani AM, Alharbi TJ, Rsheed AMB, AlRasheed AN, AlBattal SM, Abdelhay O, Hassali MA, Alrasheedy AA, Al Harbi NG, Alqahtani A. Hypoglycemia in Type 2 Diabetes Mellitus patients: A review article. Diabetes Metab Syndr. 2018;12(5):791-794. doi: 10.1016/j.dsx.2018.04.004. Epub 2018 Apr 12. PMID: 29678605.9.

9. Wolfsdorf JI, Glaser N, Agus M, Fritsch M, Hanas R, Rewers A, Sperling MA, Codner E. ISPAD Clinical Practice Consensus Guidelines 2018: Diabetic ketoacidosis and the hyperglycemic hyperosmolar state. Pediatr Diabetes. 2018;19 Suppl 27:155-177. doi: 10.1111/pedi.12701. PMID: 29900641.

10. Romero Cevallos EI, López Laaz SA, Osorio Coronel GE, Chumbi Zumba PA. Síndrome hiperosmolar hiperglucémico. RECIAMUC. 2020;4(3):227–34.

11. R R, M.R. M, Kumar SP. Mucormycosis Following Tooth Extraction in a Diabetic Patient: A Case Report. Cureus. 2020 Aug 15;

12. Fonseca Escobar D, Parada Fernández F, Carvajal Guzmán M, Sepúlveda Verdugo C, Cortés Vásquez S. Manejo odontológico del paciente diabético. Revisión narrativa. Rev Asoc Odontol Argent. 2021.

13. Dhanavelu P, Senthilnathan R, Vijay Aravind R. Diabetes mellitus and extraction. Drug Invent Today. 2019;11(9):2217–9.

14. Aishwarya S, Senthil Murugan P, Suresh V. Comparison of post extraction healing in diabetic patients with two different blood glucose levels a case control study. Int J Dent Oral Sci. 2021;8(7):3124–8.

15. Gupta B. Assessment of post operative wound healing in diabetic patients after extraction. Int J Adv Sci Res. 2017;3(7):77.

16. Gholinejad Ghadi N, Seifi Z, Shokohi T, Aghili SR, Nikkhah M, Vahedi Larijani L, Ghasemi M, Haghani I. Fulminant mucormycosis of maxillary sinuses after dental extraction inpatients with uncontrolled diabetic: Two case reports. J Mycol Med. 2018;28(2):399-402. doi: 10.1016/j.mycmed.2018.01.003. Epub 2018 Mar 13. PMID: 2954512 2.

17. Prabhu S, Alqahtani M, Al Shehabi M. A fatal case of rhinocerebral mucormycosis of the jaw after dental extractions and review of literature. J Infect Public Health. 2018;11(3):301–3.

18. Krishnan B, Prasad GA, Saravanan R, Madhan B, Kadhiravan T. Do preoperative glycosylated hemoglobin (HbA1C) and random blood glucose levels predict wound healing complications following exodontia in type 2 diabetes mellitus patients?—a prospective observational study. Clin Oral Investig. 2020;

19. Okonkwo UA, Dipietro LA. Diabetes and wound angiogenesis. Int J Mol Sci. 2017;18(7):1–15.

20. KO KI, SCULEAN A, GRAVES DT. Diabetic wound healing in soft and hard oral tissues. Transl Res. 2021;236:72–86.

21. Rela R, Sejao AV, Singh A, Singh PK, Kumar M, Gupta SK, Rangari P. Antibiotic Prescribing Knowledge, Awareness, and Attitude of Dental Surgeons Practicing in the Urban Indian Population. J Pharm Bioallied Sci. 2021;13(Suppl 2):S1637-S1641. doi: 10.4103/jpbs.jpbs_394_21. Epub 2021 Nov 10. PMID: 35018045; PMCID: PMC8686960.

22. Maftei GA, Martu MA, Martu MC, Popescu D, Surlin P, Tatarciuc D, Popa C, Foia LG. Correlations between Salivary Immuno-Biochemical Markers and HbA1c in Type 2 Diabetes Subjects before and after Dental Extraction. Antioxidants (Basel). 2021 Oct 30;10(11):1741. doi: 10.3390/antiox10111741. PMID: 34829612; PMCID: PMC8615044.

23. Radović K, Brković B, Roganović J, Ilić J, Milić Lemić A, Jovanović B. Salivary VEGF and post-extraction wound healing in type 2 diabetic immediate denture wearers. Acta Odontol Scand. 2022;80(1):9–14.

24. Power DJ, Sambrook PJ, Goss AN. The healing of dental extraction sockets in insulin-dependent diabetic patients: a prospective controlled observational study. Aust Dent J. 2019;64(1):111–6.

ISSN Print 0719-2460 - **ISSN Online** 0719-2479.

25. Gadicherla S, Smriti K, Roy S, Pentapati KC, Rajan J, Walia A. Comparison of extraction socket healing in non-diabetic, prediabetic, and type 2 diabetic patients. Clin Cosmet Investig Dent. 2020;12:291–6.

26. Shakeel J, Siddiq M, Mushtaq O, Raza SA, Rauf Z, Rathi AJ. Pattern of tooth extraction in a Tertiary Care Hospital-Karachi, Pakistan. Professional Med J. 2022; 29(6):905-911. doi: 10.29309/TPMJ/2022.29.06.6508

27. Wang WY, Wang J, Wang EB. Correlation analysis of pre-operative glucose control targets and tooth extraction prognosis in elderly diabetic patients. Zhonghua Kou Qiang Yi Xue Za Zhi. 2021;56(1):70–4.

28. Hoyos-R JD, Jaimes-O S, Alvear JD, Toloza C NA, Vásquez-F DM, Velandia-G JN, Velasco AV. Factores fisiopatológicos y metas terapéuticas perioperatorias que influyen en procedimientos quirúrgicos reconstructivos mediante colgajos en pacientes con Diabetes Mellitus. Rev Médicas UIS. 2017;30(1):35–43.

29. Agani Z, Ahmedi J, Ademi Abdyli R, Prekazi Loxha M, Hamiti-Krasniqi V, Rexhepi A, Stubljar D. The changes in levels of blood cortisol, glucose, and oxygen saturation in type 2 diabetic patients during tooth extraction. Clin Exp Dent Res. 2022;8(6):1449-1455. doi: 10.1002/cre2.641. Epub 2022 Jul 31. PMID: 35909305; PMCID: PMC9760155.

30. Yang S, Li Y, Liu C, Wu Y, Wan Z, Shen D. Pathogenesis and treatment of wound healing in patients with diabetes after tooth extraction. Front Endocrinol. 2022;13:949535.

31. Sambrook PJ, Goss AN. Contemporary exodontia. Aust Dent J. 2018;63:S11–8.

32. Piedade EFS, Gulinelli JL, Queiroz TP, Rosa VM, Santos PL. Surgical complications in systemically compromised patients: analysis of 992 medical records. RGO, Rev Gaúch Odontol. 2020;68: e20200031. http://dx.doi.org/10.1590/1981-86372020000312019000 5

33. Muzaffar A, Murtaza B, Muzaffar A, Qunain R, Iqtidar Z, Sherazi U. Comparison of Post-tooth extraction Wound healing in Patients with Optimal Diabetes control and Poor Diabetes control. Isra Med J. 2020; 12(4): 197-201.

34. Lund Håheim L, Rønningen KS, Enersen M, Olsen I. The Predictive Role of Tooth Extractions, Oral Infections, and hs-C-Reactive Protein for Mortality in Individuals with and without Diabetes: A Prospective Cohort Study of a 12 1/2-Year Follow-Up. J Diabetes Res. 2017;2017:9590740. doi: 10.1155/2017/9590740. Epub 2017 Jun 21. PMID: 28713837; PMCID: PMC5497614.

35. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, Collins BS, Hilliard ME, Isaacs D, Johnson EL, Kahan S, Khunti K, Leon J, Lyons SK, Perry ML, Prahalad P, Pratley RE, Seley JJ, Stanton RC, Gabbay RA, on behalf of the American Diabetes Association. 6. Glycemic Targets: Standards of Care in Diabetes-2023. Diabetes Care. 2023;46(Suppl 1):S97-S110. doi: 10.2337/dc23-S006. PMID: 36507646; PMCID: PMC9810469.

36. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, Collins BS, Hilliard ME, Isaacs D, Johnson EL, Kahan S, Khunti K, Leon J, Lyons SK, Perry ML, Prahalad P, Pratley RE, Seley JJ, Stanton RC, Gabbay RA, on behalf of the American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Care in Diabetes-2023. Diabetes Care. 2023;46(Suppl 1):S19-S40. doi: 10.2337/dc23-S002. Erratum in: Diabetes Care. 2023: Erratum in: Diabetes Care. 2023 Sep 1;46(9):1715. PMID: 36507649; PMCID: PMC9810477.