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ORIGINAL RESEARCH

Analysis of Risk Factors for Post-Extraction Bleeding and Study on Emergency Intervention Strategies

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Objective: The objective of this investigation is to delineate the distributional attributes of factors correlated with post-tooth extraction bleeding and to scrutinize corresponding strategies for emergency prevention and intervention.

Methods: The chi-squared test and rank sum test were deployed to evaluate fluctuations in blood loss. Univariate and multivariate binary logistic regression methodologies were employed to compute the odds ratio (OR) and its associated 95% confidence interval (95% CI). Furthermore, we delved into the relationship between each contributing factor and blood loss. Concurrently, univariate and multivariate logistic regression techniques were utilized to probe the nexus between blood loss and treatment modalities.

Results: Following adjustments for pertinent factors, the outcomes of multivariate analyses unveiled an escalated susceptibility to bleeding among male patients and individuals aged 60 years or older. The adjusted OR values and their corresponding 95% CI were determined as follows: OR = 1.54 (95% CI: 1.34–1.77, $P < 0.001$), OR = 0.74 (95% CI: 0.59–0.91, $P = 0.005$), OR = 0.58 (95% CI: 0.42–0.80, $P = 0.001$). Additionally, the results of multivariate logistic regression analysis indicated that, in contrast to individuals experiencing minimal blood loss, the OR values associated with treatment modalities for patients encountering substantial blood loss, namely iodoform gauze strips, sutures, collagen, and compression, were noted as follows: OR = 220.80 (95% CI: 151.43–321.95, $P < 0.001$), OR = 69.40 (95% CI: 46.11–104.44, $P < 0.001$), OR = 52.78 (95% CI: 34.66–80.38, $P < 0.001$), OR = 12.85 (95% CI: 9.46–17.45, $P < 0.001$).

Conclusion: It is imperative to prioritize the scrutiny of risk factors associated with post-tooth extraction hemorrhage, with the aim of preemptively averting incidences of bleeding subsequent to tooth extraction. Moreover, it is paramount to offer expert and tailored emergency interventions designed to address diverse case scenarios.

Keywords: bleeding, clinical treatment, emergency, tooth extraction

Introduction

Hemorrhage subsequent to dental extraction constitutes a prevalent complication and ranks among the most frequently encountered conditions in oral emergency departments.[1] Although the majority of postoperative bleeding does not inflict severe physiological harm, its ramifications on the patient's mental and psychological well-being can be substantial.[2] Previous research has predominantly concentrated on assessing the impact of preoperative assessments and intraoperative procedures on bleeding incidence; however, a significant proportion of post-tooth extraction bleeding transpires in the hours or days following the surgical intervention. During this period, practitioners often lack comprehensive knowledge

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pertaining to the preoperative and intraoperative circumstances surrounding their treated patients. Consequently, the analysis and management of post-tooth extraction bleeding has emerged as a pertinent subject for investigation.

Consequently, exploring methodologies for emergency physicians to expeditiously and meticulously conduct clinical analyses using pertinent information, and subsequently addressing such incidents in a prompt and appropriate manner, warrants heightened consideration. The variables under scrutiny in this study encompass patient demographics, including age and gender, overall health status, bleeding duration, dental positioning, among other influencing factors, all of which can be ascertained during emergency care. By incorporating diverse treatment modalities such as medical directives, compression, suturing, packing, etc., a comprehensive examination of potential patterns was conducted employing a substantial dataset of clinical cases. The objective is to offer guidelines derived from empirical evidence to inform the clinical practices of healthcare practitioners. The present study involves a retrospective analysis of patients presenting at our hospital's emergency department with post-tooth extraction bleeding between 2017 and 2022, with ensuing findings outlined below.

Clinical Data

General Data

A comprehensive cohort comprising 4260 individuals diagnosed with post-tooth extraction bleeding at our hospital's emergency department during the period spanning January 2017 to December 2022 was established. The selection process involved the meticulous selection of patients with fully documented medical records, adhering to specific inclusion and exclusion criteria:

Inclusion Criteria

Within the period spanning from January 1, 2017, to December 31, 2022, a comprehensive cohort comprising 6369 individuals received a diagnosis of "post-tooth extraction bleeding" within the emergency department of our medical facility.

Exclusion Criteria

1. Patients exhibiting an absence of data within each respective variable.
2. Patients presenting indeterminate data within each variable, or patients with data that does not conform to conventional parameter recording.

Research Methods

General Condition

Comprehensive health information of individuals has been collected, including gender, age, tooth location, duration of bleeding, immediate intervention methods, while also documenting whether the patient has a history of comorbidities such as hypertension and coronary heart disease. Subsequently, the patient cohort was stratified into distinct age groups: young individuals (age ≤ 44 years), middle-aged individuals (age 45–59 years), and elderly individuals (age ≥ 60 years), adhering to the age categorization stipulated by the WHO. Treatment modalities were further categorized into the following groups: medical directives, compression, suturing, application of absorbable materials (collagen sponge), and application of non-absorbable materials (iodoform gauze strips). The quantification of blood loss was dichotomized into substantial (active bleeding) and minimal (minimal oozing) blood loss.

Statistical Methods

The data underwent analysis utilizing the SPSS software version 25.0. Count data are represented as n (%), and measurement data deviating from a normal distribution, as verified by normality testing, are expressed in medians (IQRs). The variable for differential comparison was predicated on the quantity of blood loss. The chi-squared test was employed for comparing count data, while the Mann–Whitney *U*-test was utilized for comparing measurement data. Univariate and multivariate binary logistic regression analyses were conducted, with blood loss serving as the dependent variable and statistically significant indicators from the difference analysis serving as independent variables.

Concurrently, univariate and multivariate logistic regression analyses were conducted, with the treatment method designated as the dependent variable and blood loss as the independent variable. The OR value and its 95% CI were calculated for these analyses. A two-sided significance level was set at $\alpha = 0.05$, and statistical significance was established if $P < 0.05$.

Results

Outcomes

General Condition of the Patients

After screening, a total of 4260 patients were ultimately included in this study. Among them, 3383 (79.4%) patients were aged ≤ 44 years, comprising 2309 (54.2%) males and 1951 (45.8%) females. Furthermore, 297 (7.0%) patients exhibited hypertension, 205 (4.8%) displayed abnormal coagulation function, and a majority of the 3167 (74.3%) patients experienced a substantial volume of blood loss.

The outcomes of the comparative analysis revealed a lack of statistically significant differences in bleeding time, hypertension, and abnormal coagulation function between the groups characterized by substantial or minimal blood loss ($P > 0.05$). Conversely, in relation to the group experiencing minimal blood loss, individuals within the group exhibiting substantial blood loss were discerned as notably younger, predominantly male, possessed a higher prevalence of mandibular wisdom teeth, and predominantly underwent treatment involving iodoform gauze strips, with statistically significant differences observed ($P < 0.05$) (Table 1).

Binary Logistic Regression Analyses of Each Influencing Factors and Blood Loss

Univariate logistic regression analysis revealed that being male constituted a risk factor for a substantial volume of blood loss, thereby elevating the likelihood of experiencing massive bleeding. Conversely, patients aged ≥ 60 years and those

Table 1 Comparison of the General Conditions of the Study Participants

Variables	General Group (n = 4260)	Patients with Minimal Blood Loss (n = 1093)	Patients with Substantial Blood Loss (n = 3167)	χ2 or Z	P
Bleeding time (h)	6.00(3.00,24.00)	6.00(3.00,24.00)	6.00(4.00,24.00)	−1.335	0.182
Age				17.385	<0.001
≤ 44 years	3383(79.4)	843(77.1)	2540(80.2)		
45–59 years	371(8.7)	83(7.6)	288(9.1)		
≥ 60 years	506(11.9)	167(15.3)	339(10.7)		
Sex				39.647	<0.001
Female	1951(45.8)	590(54.0)	1361(43.0)		
Male	2309(54.2)	503(46.0)	1806(57.0)		
Hypertension				2.213	0.137
No	3963(93.0)	1006(92.0)	2957(93.4)		
Yes	297(7.0)	87(8.0)	210(6.6)		
Abnormal coagulation function				3.493	0.062
No	4055(95.2)	1029(94.1)	3026(95.5)		
Yes	205(4.8)	64(5.9)	141(4.5)		
Teeth position				29.428	0.001
Primary teeth	33(0.8)	13(1.2)	20(0.6)		
Maxillary molars	396(9.3)	99(9.1)	297(9.4)		
Maxillary premolars	242(5.7)	88(8.1)	154(4.9)		
Maxillary anterior teeth	94(2.2)	31(2.8)	63(2.0)		
Maxillary wisdom teeth	944(22.2)	259(23.7)	685(21.6)		
Mandibular molars	398(9.3)	97(8.9)	301(9.5)		
Mandibular premolars	77(1.8)	23(2.1)	54(1.7)		
Mandibular anterior teeth	53(1.2)	16(1.5)	37(1.2)		
Mandibular wisdom teeth	2013(47.3)	465(42.5)	1548(48.9)		

(*Continued*)

Table 1 (Continued).

Variables	General Group (n = 4260)	Patients with Minimal Blood Loss (n = 1093)	Patients with Substantial Blood Loss (n = 3167)	χ2 or Z	P
Treatment				1728.545	<0.001
Iodoform gauze strips	1758(41.3)	65(5.9)	1693(53.5)		
Suture	459(10.8)	51(4.7)	408(12.9)		
Collagen	334(7.8)	47(4.3)	287(9.1)		
Compression	1198(28.1)	473(43.3)	725(22.9)		
Doctor's order	511(12.0)	457(41.8)	54(1.7)		
Amount of blood loss				/	/
Small	1093(25.7)	/	/		
Large	3167(74.3)	/	/		

subjected to suture treatment exhibited protective effects against significant blood loss, consequently diminishing the risk of encountering massive bleeding. In comparison to the group with minimal blood loss, the *OR* values and their corresponding 95% CI were as follows: *OR* = 1.56 (95% CI: 1.36–1.79, $P < 0.001$), *OR* = 0.67 (95% CI: 0.55–0.82, $P < 0.001$), and *OR* = 0.64 (95% CI: 0.47–0.89, $P = 0.007$).

Upon conducting multivariate analysis with adjustments, the results demonstrated the persistent influence of gender, age ≥ 60 years, and suture treatment. The adjusted *OR* values and their associated 95% CIs were as follows: *OR* = 1.54 (95% CI: 1.34–1.77, $P < 0.001$), *OR* = 0.74 (95% CI: 0.59–0.91, $P = 0.005$), and *OR* = 0.58 (95% CI: 0.42–0.80, $P = 0.001$) (Table 2).

1. Multivariate logistic regression analysis of blood loss and treatment methods.

Univariate logistic regression analysis demonstrated that in comparison to patients experiencing a minimal blood loss, the *OR* values associated with various treatment modalities for patients encountering a substantial blood loss, namely

Table 2 Results of Binary Logistics Regression Analysis Between Each of the Influencing Factors and Blood Loss

Variables	Univariate			Multivariate		
	OR	95% CI	P	OR	95% CI	P
Age						
< 44 years	1.00	/	/	1.00	/	/
44–60 years	1.15	0.89~1.49	0.280	1.18	0.90~1.53	0.229
≥ 60 years	0.67	0.55~0.82	<0.001	0.74	0.59~0.91	0.005
Sex						
Female	1.00	/	/	1.00	/	/
Male	1.56	1.36~1.79	<0.001	1.54	1.34~1.77	<0.001
Teeth position						
No		/	/	1.00	/	/
Primary teeth	1.00	0.07~2.10	0.270	0.34	0.06~1.91	0.223
Maxillary molars	0.75	0.16~3.59	0.719	0.72	0.15~3.50	0.685
Maxillary premolars	0.44	0.09~2.11	0.303	0.39	0.08~1.91	0.247
Maxillary anterior teeth	0.51	0.10~2.54	0.409	0.54	0.11~2.75	0.462
Maxillary wisdom teeth	0.66	0.14~3.13	0.602	0.57	0.12~2.74	0.483
Mandibular molars	0.78	0.16~3.72	0.751	0.72	0.15~3.46	0.677
Mandibular premolars	0.59	0.12~2.98	0.520	0.58	0.11~2.96	0.509
Mandibular anterior teeth	0.58	0.11~3.03	0.517	0.59	0.11~3.14	0.538
Mandibular wisdom teeth	0.83	0.18~3.93	0.817	0.70	0.15~3.36	0.656

Note: Age, sex, and teeth position were adjusted for multivariate analyses.

Table 3 Results of Multivariate Logistics Regression Analysis Between Blood Loss and Various Treatment Methods

Treatment	Variables	Univariate			Multivariate		
		OR	95% CI	P	OR	95% CI	P
Iodoform gauze strips	Minimal blood loss	1.00	/	/	1.00	/	/
	Substantial blood loss	220.43	151.44~320.84	<0.001	220.80	151.43~321.95	<0.001
Suture	Minimal blood loss	1.00	/	/	1.00	/	/
	Substantial blood loss	67.70	45.14~101.54	<0.001	69.40	46.11~104.44	<0.001
Collagen	Minimal blood loss	1.00	/	/	1.00	/	/
	Substantial blood loss	51.68	34.02~78.49	<0.001	52.78	34.66~80.38	<0.001
Compression	Minimal blood loss	1.00	/	/	1.00	/	/
	Substantial blood loss	12.97	9.56~17.60	<0.001	12.85	9.46~17.45	<0.001

iodoform gauze strips, suture, collagen, and compression, were determined as follows: *OR* = 220.43 (95% CI: 151.44–320.84, $P < 0.001$), *OR* = 67.70 (95% CI: 45.14~101.54, $P < 0.001$), *OR* = 51.68 (95% CI: 34.02~78.49, $P < 0.001$), *OR* = 12.97(95% CI: 9.56~17.60, $P < 0.001$). Notably, the adjusted results obtained from the multivariate analysis exhibited no significant alteration. The adjusted *OR* values and their corresponding 95% CIs were as follows: *OR* = 220.80 (95% CI: 151.43–321.95, $P < 0.001$), *OR* = 69.40 (95% CI: 46.11~104.44, $P < 0.001$), *OR* = 52.78 (95% CI: 34.66~80.38, $P < 0.001$), *OR* = 12.85 (95% CI: 9.46~17.45, $P < 0.001$) (Table 3).

Discussion

Hemorrhage constitutes a prevalent complication subsequent to dental extractions.[1–3] Existing studies primarily concentrate on preoperative challenges associated with tooth extraction and the surgical procedures performed during the operation as pivotal factors influencing postoperative bleeding.[1] Nevertheless, instances of bleeding following tooth extraction are more prone to manifest within the initial 2–6 hours and 1–2 days post-surgery. Patients encountering such complications often face challenges in promptly consulting the extracting surgeon and instead opt for seeking assistance at emergency departments or nearby clinics.[4] In instances where a physician is confronted with such cases, the ability to swiftly analyze the limited information available becomes imperative. The undertaking of effective hemostatic measures under constrained conditions, necessitated by the absence of comprehensive preoperative and intraoperative details, constitutes a critical objective within the scope of this study.

Hemorrhage subsequent to dental extraction is categorized into primary and secondary manifestations. Primary bleeding manifests as persistent hemorrhaging within the initial 24 hours postoperatively, while secondary bleeding transpires beyond the initial 24 hours following the surgical intervention.[1,5] Extended intervals between the surgical procedure and the onset of bleeding necessitate heightened medical vigilance. Such delays suggest inadequacies in the patient's daily regimen and maintenance practices, rendering them ineffectual in preventing hemorrhage, and improper procedural conduct may serve as a causative factor for bleeding.

In the present study, gender distribution exhibited approximate parity; nonetheless, a discernibly elevated prevalence of males was observed within the subset experiencing substantial blood loss. This phenomenon may be associated with suboptimal patient adherence, heightened prevalence of smoking habits, substandard oral hygiene, and underlying systemic conditions conducive to bleeding.[3,6,7] Additionally, the augmented hardness of bones in male patients, coupled with the surgical maneuvers involved in dislodging teeth during extraction procedures, potentially results in increased trauma. This aspect warrants heightened consideration during the postoperative phase, particularly with respect to hemostasis interventions.

Systemic ailments such as hypertension and aberrant coagulation functionality do not constitute predisposing factors for the extent of hemorrhage; however, these details are imperative during the consultation phase.[8] Explicit directives advocate against the discontinuation of systemic medications during dental surgical procedures.[9–12] Consequently, medical practitioners must exercise heightened prudence in determining hemostatic interventions in such instances. It is crucial to underscore that the ability to arrest local bleeding remains feasible, and adherence to standardized clinical protocols remains foundational and assures the efficacy of interventions for post-tooth extraction hemorrhage.[12–14]

There was an elevated prevalence of patients exhibiting mandibular wisdom teeth and maxillary molars in this study. Mandibular wisdom teeth typically manifest as impacted teeth, necessitating interventions that may precipitate bleeding, including flapping, deboning, and crown incisions.[15] The majority of molars are characterized by multiple roots, and those requiring extraction predominantly manifest severe periodontitis or tooth fragmentation. Noteworthy sources of bleeding during intraoperative procedures encompass granulation tissue and the incision of tooth roots, underscoring the importance of vigilant consideration in the course of surgical operations.

Hemorrhage represents a prevalent concern within the oral emergency domain,[3,16,17] necessitating clinicians to adopt a comprehensive approach when addressing post-tooth extraction bleeding. Initially, practitioners should cultivate a mental readiness for managing this clinical exigency.[2] This study reveals that patients experiencing substantial blood loss constitute 74.3% of cases, encompassing pulsatile bleeding from vascular trauma and persistent bleeding resulting from alveolar bone and soft tissue injuries. Dentists are advised to maintain composure and ensure their capability to effectively navigate such commonplace scenarios.

Subsequently, in order to facilitate prompt and accurate comprehension of the surgical condition of the patient by the attending physician in the emergency setting, the primary healthcare provider should meticulously assess immediate socket status following tooth extraction. This assessment encompasses aspects such as the presence of residual granulation, tooth root remnants, soft and hard tissue integrity, vascular damage, and quantification of blood loss. Documentation of these findings in the medical record is imperative to furnish pertinent information for emergent intervention. Additionally, the provision of preoperative x-rays, if available, serves as valuable supplementary data for subsequent clinical consultations.

Lastly, proactive preparation of instruments and materials is imperative in clinical practice. This encompasses ensuring an optimal examination environment through the availability of a proficient lighting system, negative pressure saliva suction system, and an opener, thereby ensuring an unobstructed field of vision and operational space. Essential materials for hemorrhage management include iodoform gauze, absorbable hemostatic agents (such as collagen sponge, fibrin glue, etc.), and sutures. These preparations collectively contribute to the effective and expedient management of post-tooth extraction bleeding incidents.

In the present study, the management of post-tooth extraction hemorrhage was categorized into distinct therapeutic modalities, including medical directives, compression, suturing, application of iodoform gauze strips, and utilization of absorbable materials, specifically collagen sponge.[4,5] In instances of minimal blood loss, physicians commonly rely on verbal instructions to patients rather than resorting to invasive interventions.

Nevertheless, it is imperative to emphasize the necessity for meticulous observation and real-time assessment of minor hemorrhagic events,[1] ensuring that patients do not revisit the clinic for identical concerns post-discharge. Furthermore, medical directives play a pivotal role in assuaging patient anxiety and mitigating potential medical disputes. Hence, clinicians are urged to furnish comprehensive and easily comprehensible medical instructions, resorting to written directives when deemed essential.[2]

Under conditions of normal coagulation, compression emerges as an uncomplicated and efficacious approach for arresting bleeding. However, practitioners must attend to specific details, such as ensuring complete coverage of the bleeding wound by the hemostatic cotton roll. Furthermore, it is crucial that the force exerted by opposing jaw teeth or fingers is directed exclusively to the bleeding site through the cotton roll, avoiding contact with adjacent teeth or soft tissues. To enhance hemostasis, the cotton roll may be moistened prior to application. Suturing, either in isolation or in conjunction with hemostatic packing, constitutes a viable option. Preferably, round or contra-angled needles should be employed, with careful consideration given to soft tissue insertion points capable of withstanding adequate traction to prevent secondary trauma during hemostasis.

Hemostatic materials for packing are categorized as either absorbable or non-absorbable.[18] Non-absorbable materials necessitate removal approximately one week postoperatively. It is noteworthy that the extraction of iodoform gauze strips may induce recurrent bleeding, necessitating forewarning and preparedness for additional hemostatic measures. The mechanism underlying iodoform gauze strip application involves exerting pressure within the socket to stem bleeding, differing from the methodology employed with absorbable collagen sponge treatment. The collagen sponge, characterized by a reticulated porous structure, facilitates blood adsorption and provides an advantageous framework for endogenous clot formation. Consequently, during collagen sponge packing, efforts should be made to maintain the original shape of the material, ensuring optimal expansion within the sockets. In cases where suturing is concomitantly employed, the collagen sponge should precede suturing to prevent deformation caused by insertion into inadequately sized entrances, thereby preserving the hemostatic efficacy.[19]

There exist limitations that could impact the interpretation and broader applicability of the findings. To begin with, this study predominantly relied on retrospective case analysis, constraining our ability to comprehensively evaluate patients' hemostatic outcomes. Retrospective studies hinge on existing medical records, which may be incomplete or inaccurate, thus failing to capture the complete hemostatic picture following urgent clinical interventions. Moreover, retrospective data often lack standardization and consistency, potentially introducing biases in the interpretation of results. Secondly, the size and composition of the sample could potentially skew the study outcomes. Despite encompassing a substantial number of clinical cases, the sample's representativeness may still be influenced by variables such as geographical location, hospital type, patient demographics, and gender distribution. Additionally, the study did not conduct in-depth stratified analyses of various subgroups (eg, different bleeding etiologies, treatment modalities), potentially obscuring crucial differences and correlations. Furthermore, this study did not adequately account for potential confounding variables, such as patients' overall health status, comorbidities, or complications. These factors could significantly impact hemostatic outcomes but were not sufficiently controlled for or adjusted in this study. Lastly, the study's results primarily relied on statistical analyses, lacking a profound exploration of underlying mechanisms. This limitation restricts our comprehension of bleeding and hemostasis mechanisms, impeding the development of more efficacious treatment strategies in the future. Given these limitations, future research endeavors could enhance and broaden their scope in the following ways: Firstly, conducting prospective studies to gather more comprehensive and precise data through robust design and execution, thus enabling a more accurate assessment of hemostatic outcomes. Secondly, augmenting sample size and improving sample representativeness to more comprehensively capture the characteristics and variances of diverse patient cohorts. Simultaneously, performing detailed stratified analyses of various subgroups to unveil potential disparities and correlations.

Conclusion

This article analyzed the factors related to post-extraction bleeding and emergency management measures, finding that male individuals and patients over 60 years old are at higher risk of bleeding. Different treatment modalities have varying effectiveness for significant bleeding, with iodine gauze, suturing, collagen, and compression showing notable hemostatic effects. In conclusion, post-extraction care should prioritize risk assessment and select appropriate treatment measures based on the bleeding severity.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Peking University School and Hospital of Stomatology. A written informed consent was obtained from all participants.

Disclosure

The authors report no conflicts of interest in this work.

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