Risk factors in oroantral communication while extracting the upper third molar: Systematic review

Czynniki ryzyka połączenia ustno-zatokowego podczas usuwania górnego trzeciego zęba trzonowego – systematyczny przegląd piśmiennictwa

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Abstract

The removal of the upper third molar is a procedure commonly performed in oral and maxillofacial surgery. Maxillary third molars are generally less difficult to extract than mandibular third molars. The surgical removal of maxillary third molars is usually associated with low complication rates and low morbidity. This procedure involves the risk of developing complications such as oroantral communication, displacement into adjacent anatomic spaces, fracture of the maxillary tuberosity, and root fracture. Orthopantomograms are the standard preoperative imaging modality, but there is no proven tool for predicting oroantral communication. New possibilities have been offered by cone-beam computed tomography (CBCT), which is increasingly used in dentistry and is an innovative technique that provides more information as it eliminates the superimposition of surrounding structures and allows the acquisition of 3-dimensional images and their qualitative assessment. The aim of this systematic review was to assess risk factors during the extraction of the upper third molar using orthopantomograms and CBCT.

Key words: cone-beam computed tomography, radiography, third molar, oroantral fistula

Słowa kluczowe: stożkowa tomografia komputerowa, radiografia, trzeci ząb trzonowy, połączenie ustno-zatokowe

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Introduction

The development of the maxillary sinus begins in the fetal phase of life and ends with the eruption of the third upper molar. Maxillary sinus shape alterations may lead to the formation of a recess. Alveolar recesses are usually situated between the 2 laminas dura of the alveolar process. Less frequently, the recesses are located between the roots of the teeth, or the interradicular or interdental septa. An alveolar recess may cause a protrusion of the lateral tooth roots into the lumen of the maxillary sinus. Protruding roots may be only covered by a thin layer of mucosa as a consequence of bone lamina atrophy.[1–3]

The removal of the upper third molar (UTM) is a procedure commonly performed in oral and maxillofacial surgery. This procedure involves the risk of developing complications such as oroantral communication (OAC), displacement into adjacent anatomic spaces, fracture of the maxillary tuberosity, and root fracture.[4–7] The frequency of OAC after UTM extraction noted in the literature is 0.8%.[8] Oroantral communication of less than 2 mm may spontaneously heal within 48 h after extraction, OAC greater than 3–4 mm is not expected to resolve itself without intervention and requires surgical treatment.[9]

Orthopantomograms (OPG) are standard preoperative imaging modalities. However, the assessment of the exact position of UTM roots relative to the maxillary sinus using OPG can be confusing. This is due to the shortcomings of this imaging method, including magnification and distortion effects. Cone-beam computed tomography (CBCT) is an innovative technique that provides greater information as it eliminates the superimposition of surrounding structures, as well as allows the acquisition of 3-dimensional images and their qualitative assessment.[7,10]

Therefore, the aim of this systematic review was to assess any risk factors during the extraction of the UTM using orthopantomograms and CBCT.

Material and methods

A systematic review (SR) of the literature concerning OPG and CBCT in the evaluation of risk factors of oroantral communication during the extraction of the third upper molar was executed using PubMed (MEDLINE), Scopus and ScienceDirect databases on February 24, 2017. The search equations used for different databases are presented in Table 1.

A time frame between January 1, 2007 and December 31, 2016 was applied. Only publications in English, including peer-reviewed journals, were considered. The titles and abstracts obtained during the electronic search were screened and evaluated by 2 observers for eligibility according to inclusion and exclusion criteria (Table 2). Studies not meeting the inclusion criteria were excluded from further evaluation.

Any discrepancies in the selection were settled through discussion. After verification with respect to the aforementioned criteria, an additional search took place focusing on the browsing references of the acquired studies. A Prisma diagram flowchart presents the selection scheme (Fig. 1).[11]

For the purpose of this study, a data extraction form was created (Fig. 2). One review author extracted data from the studies that were included, and another author checked the forms. Information obtained from the data extraction forms were as follows: the characteristics of the participants (age, gender, diagnosis, and previous treatment), imaging method, and imaging method reliability. This review was registered in the "PROSPERO international prospective register of systematic reviews" as CRD42017071690.

Table 2. Inclusion and exclusion criteria

Inclusion criteria	in vitro and in vivo human study articles in English orthopantomograms cone-beam computed tomography upper third molars imaging study group ≥5 full-text available journal articles measurements performed in metrical manner
Exclusion criteria	animal study articles without abstracts

Table 1. Search strategy in PubMed (MEDLINE), Scopus and ScienceDirect

PubMed	(((oroantral communication[TIAB] OR oroantral perforation[TIAB] OR sinus-perforation[TIAB] OR sinus membrane perforation[TIAB] OR "Oroantral Fistula"[Mesh]) OR ("Molar, Third"[Mesh] OR maxillary third molar[TIAB] OR maxillary wisdom teeth[TIAB])) AND ("Radiography, Panoramic"[Mesh] OR pantomography[TIAB] OR "Cone-Beam Computed Tomography"[Mesh])) AND ("2007/01/31"[PDat] : "2016/12/31"[PDat] AND "humans"[MeSH Terms] AND English[lang])
Scopus	((TITLE-ABS-KEY(oroantral AND communication) OR TITLE-ABS-KEY(oroantral AND perforation) OR TITLE-ABS-KEY(sinus-perforation) OR TITLE-ABS-KEY(sinus AND membrane AND perforation) OR KEY(oroantral AND fistula)) OR ((KEY(molar, AND third) OR TITLE-ABS-KEY(maxillary AND wisdom AND teeth)) AND (KEY(radiography, AND panoramic) OR TITLE-ABS-KEY(pantomography) OR KEY(cone-beam AND computed AND tomography)))) AND (LIMIT-TO(PUBYEAR, 2016) OR LIMIT-TO(PUBYEAR, 2015) OR LIMIT-TO(PUBYEAR, 2014) OR LIMIT-TO(PUBYEAR, 2013) OR LIMIT-TO(PUBYEAR, 2012) OR LIMIT-TO(PUBYEAR, 2011) OR LIMIT-TO(PUBYEAR, 2010) OR LIMIT-TO(PUBYEAR, 2009) OR LIMIT-TO(PUBYEAR, 2008) OR LIMIT-TO(PUBYEAR, 2007)) AND (LIMIT-TO(LANGUAGE, "English"))
Science Direct	pub-date > 2006 and pub-date < 2017 and (((tak(oroantral communication) OR tak(oroantral perforation) OR tak(sinus-perforation) OR tak(sinus membrane perforation) OR key(Oroantral Fistula)) OR (key(Molar, Third) OR tak(maxillary third molar) OR tak(maxillary wisdom teeth))) AND (key(Radiography, Panoramic) OR tak(pantomography) OR key(Cone-Beam Computed Tomography)))

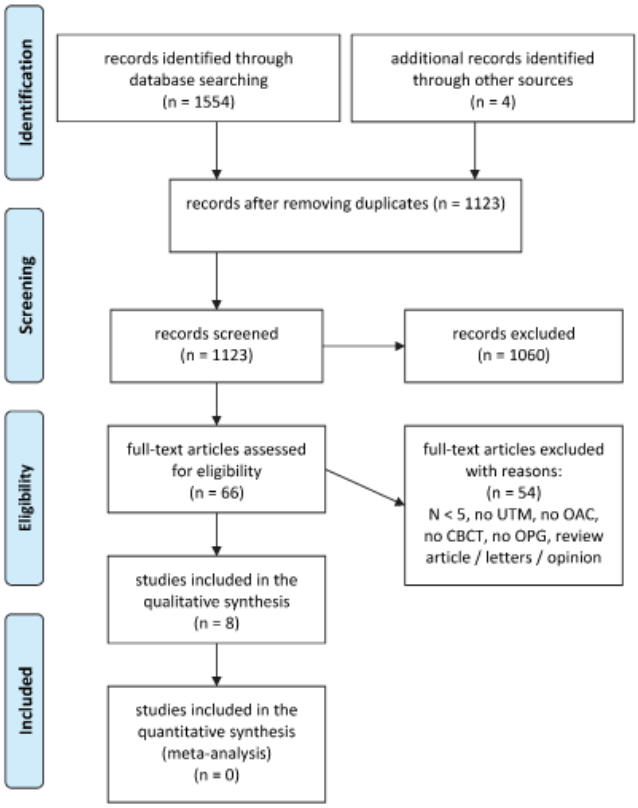

Fig. 1. Study flowchart according to the PRISMA statement[11]

Title of study				
Authors				
Year of publication				
Imaging	orthopantomograms ☐ CBCT ☐			
Study aims				
Type of study	in vitro ☐ in vivo ☐			
Sample size	randomised ☐ recruited ☐			
BASELINE CHARACTERISTICS OF PATIENTS				
	Study group	Control group	Others	p-values
Number of patients				
Age Mean/±				
Median/±				
Gender	female: male:	female: male:		
BASELINE CHARACTERIZATION OF PATIENTS (continued)				
Information	Evaluated	Statistically significant differences between groups	Notes	
Factor A				
Info 1				
Info 2				
Validation		Yes	No	
Number of observer				
Number of measurement Evaluated measurement (points, angles, plane, etc.)				
Statistical method Does the conclusion correspond with the aims?				
Does the result correspond with the aims?				

Fig. 2. Data extraction form

Data analysis

The articles which were qualified to the study contained high heterogeneity in regard to the assessment method. Therefore, a meta-analysis was not conducted and qualitative synthesis was performed.

A quality assessment instrument (QAI) was used, utilized by Kuijpers et al., to assess the level of evidence for any retrieved studies (Fig. 3). Two reviewers used the QAI independent of each other, with disagreements between the observers being resolved through discussion.[12]

I.	Study design
A.	Objective – objectives clearly formulated
B.	Sample size – considered adequate
C.	Sample size – estimated before the collection of data
D.	Selection criteria – clearly described
E.	Baseline characteristics – similar baseline characteristics
F.	Timing – prospective
G.	Randomization – stated
II.	Study measurements
H.	Measurement method – appropriate to the objective
I.	Blind measurement – blinding
J.	Reliability – adequate level of agreement
III.	Statistical analysis
K.	Dropouts – dropouts included in data analysis
L.	Statistical analysis – appropriate for data
M.	Confounders – confounders included in the analysis
N.	Statistical significance level – p-value stated
O.	Confidence intervals provided
Maximum number – 15	
✓ – should be checked if it satisfactorily fulfilled methodological criteria	
○ – should be checked if it did not fulfill the methodological criteria	
• – not applicable	

Fig. 3. Level of evidence[12]

Results

Out of 1154 articles initially identified, automatic rejection of duplicates by Mendeley Desktop v. 1.17.8 (Mendeley, London, England) resulted in 1123 articles. On verification and after taking into account the inclusion/exclusion criteria, 1060 articles were excluded. Sixty-six full-text articles were read in their entirety by 2 observers. Fifty-four articles were excluded on the basis of exclusion criteria. The final number of articles included in the study was 8 (Table 3).

Table 3. Articles included

Authors	Year of publication	OPG/CBCT	Rating
del Rey-Santamaría et al.[16]	2006	OPG	molar angulation, surgical technique and radiological sinus proximity
Demirtas et al.[19]	2016	CBCT	position of the maxillary sinus relative to the maxillary third molars
Hasegawa et al.[14]	2016	OPG	proximity of the roots to the maxillary sinus floor (root-sinus [RS] classification), relationship between the maxillary second and third molars was classified according to the modified version of the Archer classification, depth of the maxillary third molar in the bone, angulation of wisdom tooth
Jung et al.[21]	2015	OPG and CBCT	eruption level of the maxillary third molars, available retromolar space, angulation, relationship to the second molars, number of roots, and relationship between the roots and the sinus
Lewusz et al.[13]	2015	OPG	position of teeth 18 and 28, distance between the apex of the maxillary third molar and the floor of the maxillary sinus, position of UTM in relation to the cementoenamel junction of the adjacent second molar
Lim et al.[18]	2012	OPG	modified version of the Archer classification of impacted maxillary wisdom, proximity to the floor of the sinus
Nedbalski et al.[15]	2008	OPG	distance between the most superior point and the most superior root of the tooth
Pourmand et al.[17]	2014	OPG	type of retention, the relation of the tooth root to the maxillary sinus

Out of 8 articles, 2 (25%) were evaluated as good according to the methodological quality score ≥60%.[13,14] The lowest level of evidence was 20% and the highest 60%.[13–15] One study was prospective, while the others were retrospective.[16]

Oroantral communication was found to be statistically significant (p = 0.0368) more frequently in higher age groups (above 40 years of age).[17] The risk of OAC oscillated between 4.6 and 5.3%.[16,17] The risk of OAC was seen to increase with molar extraction complications, though the linear-trend χ^2 test failed to find any statistical significance ($\chi_{LT}^2 = 3.411$; df = 2; p = 0.065). Surgical extraction without osteotomy carried a 4.2% risk and surgical extraction with osteotomy carried a 7.0% risk.[16]

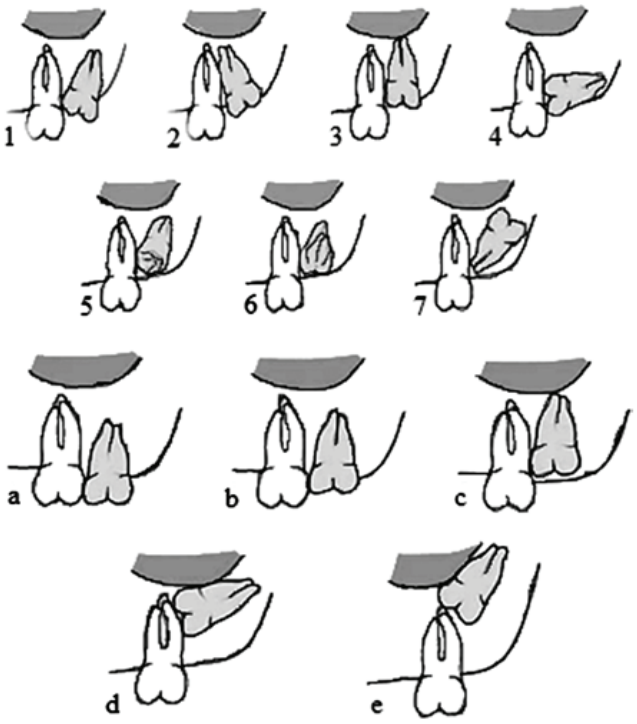

Fig. 4. Archer third molar classification
1 – mesioangular; 2 – distoangular; 3 – vertical; 4 – horizontal; 5 – buccoangular; 6 – linguoangular; 7 – inverted; a – the occlusal surface of the impacted tooth is approximately at the same level as the occlusal surface of the second molar – class A; b – the occlusal surface of the impacted tooth is at the middle of the crown of the adjacent second molar – class B; c–e – the occlusal surface of the impacted tooth crown is below the cervical line of the adjacent molar or even deeper, contiguously or even above its roots – class C.[20]

The risk of OAC is higher for mesioangular teeth, ranging from 42.9 to 69.6%. It also increased in the case of Archer classification class B at 60.9%, type 3 root-sinus classification at 87% and modified root-sinus classifications, IV being 3.1% and V at 7.1%, respectively.[14,17,18]

Both Lim et al. and Demirtas et al. used Archer's classification to arrive at comparable results in evaluating UTM position, Lim et al., on the basis of OPG and Demirtas et al. on the basis of CBCT.[18,19]

The authors of the publications evaluated the risk factors for the occurrence of OAC during the extraction of UTM on OPG using several methods:

- evaluation of the position of UTM using Archer classification or its modification;[13,14,18]
- the position of UTM in relation to the floor of the maxillary sinus;[13–15,17,18]
- the position of UTM in relation to the adjacent tooth;[13,14,16,18]
- level of UTM retention.[17]

Results and discussion

Archer classification and modification

Archer classification describes the position of the long axis of UTM relative to the long axis of the upper second molar (USM) and an evaluation of UTM retention (Fig. 4).[20] Position d matches class C (the occlusal surface of the impacted tooth crown is below the cervical

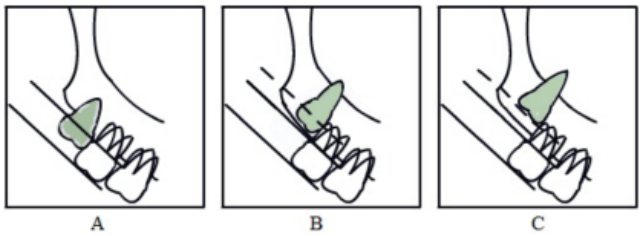

Fig. 5. The modified Archer classification
class A – UTM is between the occlusal plane of USM and the cervical line of USM; class B – UTM is between the cervical line of the USM and the middle third of its root; class C – UTM is at or above the apical third of the root of USM.[14]

line of the adjacent molar or deeper, contiguously or even above its roots) showing a statistical significance associated with the occurrence of OAC during the extraction of UTM.[13] A similar relationship was obtained in the case of class B of the modified Archer classification according to Hasegawa et al. (Fig. 5).[14] Class B after modification was equal to class C before modification, and this meant that the results obtained in the articles could be confirmed.

The position of UTM in relation to the floor of the maxillary sinus

The position of UTM relative to the maxillary sinus floor can be evaluated in a number of ways. A ruler or software to evaluate and edit OPG can be used to determine the length between the UTM apex and the maxillary sinus floor.[13,15] This method is not a particularly useful tool, and it does not show any statistical significance regarding the assessment of the risk of OAC during UTM extraction.

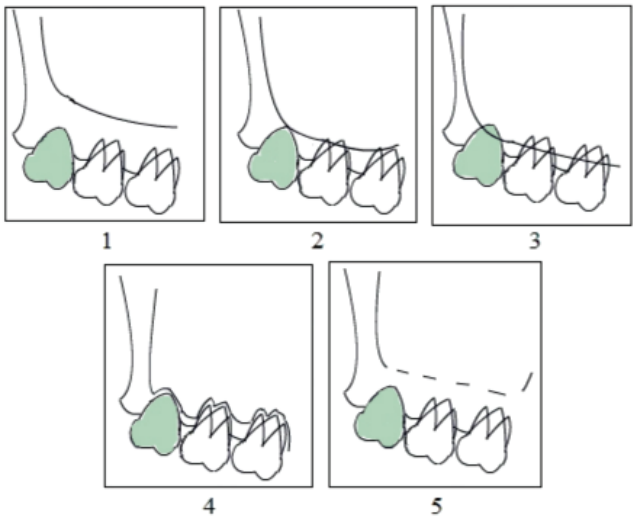

Fig. 6. Root-sinus classification
type 1 – clear distinction between the 2 features (the tooth and the sinus floor); types 2 and 3 – different degrees of radiographic superimposition of the sinus floor across the roots; type 4 – close proximity of the sinus and the roots but clear demarcation between the sinus floor and the roots; type 5 – indistinct relationship between the roots and the sinus floor.[14]

Root-sinus (RS) classification and its modifications can be a valuable tool in the prediction of OAC during UTM extraction. An increased risk of OAC occurs in type 3 of the RS classification (Fig. 6), and type 4, and type 5 (the sinus floor extends up to the trifurcation/tooth cervix) of the modified RS classification, according to Pourmand et al.[14,17]

The position of UTM in relation to the adjacent tooth

The Archer classification is used to evaluate the position of UTM in relation to the adjacent tooth. In publications that used this tool, it was shown to offer no statistical significance for predicting OAC during the UTM extraction.[13,14,18]

The UTM angulation in relation to the long axis of USM can be described according to Winter's classification. Unfortunately, in this study it was not included in the description of the results.[16]

The level of UTM retention

The degree of UTM retention is described by the following classification: type 1 – tooth bud; type 2 – root growth still incomplete; type 3 – retention with normal positioning of the axes; type 4 – mesially angled tooth; type 5 – distally angled tooth; type 6 – tooth turned horizontally toward the alveolar process. The highest incidences of OAC were observed in type 5 (7.1%) and type 3 (4.9%), while no complication was observed in the other types.[17]

Before extracting UTM, it is important to thoroughly analyze the anatomy of the tooth and its relation to the maxillary sinus. It is a standard practice to take OPG before the planned procedure. If the root and sinus floor are superimposed on the OPG, the relative probability of OAC increases during extraction.[17] In this situation, it seems necessary to obtain more information about the maxillary sinus relative to UTM in order to avoid OAC, and carry out CBCT.[21,22] It is difficult to measure the distance between UTM and the floor of the maxillary sinus. OPG are related to defects such as overlapping anatomical structures, enables horizontal and vertical magnification, and a 2-dimensional representation of a 3-dimensional structure.[8,15,18,23] There was a significant difference between OPG and CBCT measurements.[21]

Unfortunately, there are no strict guidelines regarding the role of CBCT in dentistry. It has become a substitute for conventional radiography, including periapical, bitewing and OPG. The radiation doses from full FOV dental CBCT scans have been measured to be 4–42 times the dose from OPG. An increasing number of CBCT images are performed in children who are more sensitive to radiation, particularly in the thyroid gland, testes, and breast tissue as the cancer risk per Sievert is the highest at a younger age. It is proposed to modify the concept of ALARA (as low as reasonably achievable) to ALADA (as low as diagnostically acceptable).[24]

Conclusions

Orthopantomogram assessment is not a reliable method for assessing the risk factors for oroantral communication, but CBCT seems a better tool for the assessment of the proximity of an UTM to the maxillary sinus. For this reason, if information from orthopantomograms is not clear and there is a risk of a complications, CBCT should be performed to verify the information.

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