SURGICAL TREATMENT OF ECTOPIC MAXILLARY THIRD MOLARS INVOLVING MAXILLARY SINUS – A SYSTEMATIC LITERATURE REVIEW

HIRURŠKO LEČENJE EKTOPIČNIH GORNJIH UMNJAKA UNUTAR MAKSILARNOG SINUSA – SISTEMATSKI PREGLED LITERATURE

Denis BRAJKOVIĆ[1,2], Aleksandar KIRALJ[1,2], Miroslav P. ILIĆ[1,2], Ivana MIJATOV[1,2] and Saša MIJATOV[2]
University of Novi Sad, Faculty of Medicine Novi Sad,
Department of Stomatology with Maxillofacial Surgery, Novi Sad[1]
University Clinical Center of Vojvodina, Clinic for Maxillofacial Surgery, Novi Sad[2]
Review article
UDK 616.314.8:616.21]-089
https://doi.org/10.2298/MPNS2408248B

ORCID NUMBER
Denis Brajković – 0000-0001-8484-9770
Aleksandar Kiralj – 0000-0003-4605-6408
Miroslav P. Ilić – 0000-0001-5088-4957
Ivana Mijatov – 0000-0002-4771-4102
Saša Mijatov – 0000-0003-2074-0527

Summary
Introduction. This article aims to evaluate surgical procedures for the extraction of ectopic maxillary third molars involving the maxillary sinus. **Systematic Review.** A systematic review of case reports and case series of ectopic maxillary third molars involving the maxillary sinus was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement guidelines. **Results.** A total of 45 articles reporting 79 cases of ectopic third molars met the eligibility criteria. Among the patients, 45 were male (58%) and 34 were female (42%), with a median age of 25.5 years. Dentigerous cysts were found in 75% of cases. The conventional Caldwell-Luc procedure was employed in 39% of reported cases, while the Caldwell-Luc technique with intraoral endoscopy was utilized in 15% of cases. Endoscopic sinus surgery was performed in 36% of cases, with postoperative complications reported in 10%. **Conclusion.** Based on extensive review of the literature, we can conclude that the Caldwell-Luc procedure remains the preferred method for removing ectopic teeth in the maxillary sinus, whether or not associated with dentigerous cysts. Further refinement of intraoral endoscopy linked with the Caldwell-Luc technique should be particularly considered as it may lead to its establishment as the gold standard for such interventions.
Key words: Molar, Third; Maxillary Sinus; Tooth Eruption, Ectopic; Dentigerous Cyst; Endoscopy; Treatment Outcome

Sažetak
Uvod. Cilj ovog rada bio je da se procene tehnike hirurškog lečenja ektopičnih gornjih umnjaka unutar maksilarnog sinusa. **Sistematski pregled.** Sistematski pregled prikaza slučajeva i serija slučajeva ektopičnih maksilarnih trećih molara koji zahvataju maksilarni sinus sproveden je prema *Preferred Reporting Items for Systematic Reviews and MetaAnalyses* protokolu. **Rezultati.** Ukupno 45 članaka koji prikazuju 79 slučajeva ektopičnih trećih molara ispunili su kriterijume podobnosti. Ukupno je registrovano 45 muškaraca (58%) i 34 žene (42%). Srednja starost bila je 25,5 godina. Prisustvo odontogene ciste nađeno je u 75% slučajeva. Konvencionalni *Caldvell Luc* pristup je korišćen u 49% prijavljenih slučajeva, dok je kombinovani *Caldvell Luc* pristup, uz intraoralnu endoskopiju, korišćen u 15% slučajeva. Endoskopska hirurgija sinusa rađena je u 36% slučajeva. U 10% slučajeva zabeležene su postoperativne komplikacije. **Zaključak.** Na osnovu obimnog pregleda literature možemo zaključiti da je postupak *Caldvell Luc* i dalje tretman izbora za evakuaciju ektopičnih zuba u maksilarnom sinusu sa odontogenim cistama ili bez njih. Posebna pažnja se može posvetiti daljim modifikacijama intraoralne endoskopije povezane sa *Caldvell Luc* tehnikom koja može postati zlatni standard za ovu intervenciju.
Ključne reči: treći umnjak; maksilarni sinus; ektopični zub; odontogena cista; endoskopija; ishod lečenja

Introduction

Ectopic teeth most commonly involve mandibular third molars and maxillary canines [1]. However, ectopic maxillary third molars within the maxillary sinus (MTMMS) are a rare clinical presentation. When located in the sinus cavity, these teeth may manifest with classic sinusitis symptoms such as facial pain, swelling, headache, and nasal obstruction, or they may remain asymptomatic [1]. Symptoms usually occur when a dentigerous cyst is present in the sinus cavity. The development of dentigerous cysts in the maxillary sinus related to an ectopic tooth is rare. These cystic lesions are characterized by constant growth, leading to bone resorption and the displacement of surrounding structures and teeth [1].

The diagnosis of ectopic maxillary third molars and dentigerous cysts in the maxillary sinus is made through clinical and radiological examinations. Preoperative planning for the treatment of maxillary sinus pathologies is important due to the close proximity of vital anatomical structures [2]. Surgical extraction of ectopic third molars in the maxillary sinus is indicated for symptomatic patients as well as asymptomatic patients with dentigerous cysts [1–3]. The Caldwell-Luc procedure (CL), first described in 1893, was the treatment of choice for approaching maxillary sinus lesions until the introduction of endoscopic sinus surgery [2]. The CL technique has been used for enucleation of tumors, cysts, polyps, foreign bodies, and chronic sinusitis, as well as for the reduction of facial fractures, orbital floor decompression, closure of oroantral fis-

Corresponding author: Denis Brajković, E-mail: denis.brajkovic@mf.uns.ac.rs

Abbreviations

MTMMS – ectopic maxillary third molars involving maxillary sinus
CL – Caldwell-Luc procedure
ESS – endoscopic sinus surgery
PPF – pterygopalatine fossa
CBCT – cone-beam computed tomography
CT – computed tomography
MRI – magnetic resonance imaging
PRISMA – Preferred Reporting Items for Systematic Reviews and MetaAnalyses
DC – dentigerous cyst
AM – ameloblastoma
OKC – odontogenic keratocyst

tula, access to pterygomaxillary fossa, and approaches to the sphenopalatine ganglion [1–3]. However, the CL approach is associated with frequent complications such as postoperative swelling, infraorbital nerve paresthesia, damage to the roots of adjacent teeth, oroantral fistula formation, and postoperative anterior maxillary wall defects [4, 5]. Since the introduction of endoscopic sinus surgery (ESS), many authors have reported successful endoscopic management of ectopic teeth in the maxillary sinus, highlighting the reduced risk of injury to adjacent anatomical structures and less invasive nature of the procedure [4, 5]. Common complications of ESS procedures include damage to the lacrimal duct, nasal synechiae, and orbital trauma [3–5]. Clinical trials comparing the treatment outcomes between CL and ESS in maxillary sinus surgery have reported low complication rates for both approaches in the surgical treatment of chronic sinusitis [1–5]. Although the CL procedure is no longer considered the first-line treatment for maxillary sinus pathology, it remains in use for selected cases. In the era of endoscopy, the CL procedure combined with nasal and intraoral endoscopy is used with good outcomes.

The aim of this article is to evaluate surgical procedures for the extraction of ectopic maxillary third molars involving the maxillary sinus, with or without the presence of a dentigerous cyst.

Review of the Literature

A systematic review of case reports and case series involving ectopic maxillary third molars within the maxillary sinus was conducted following the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement. In June 2022, electronic searches were performed in the PubMed (National Library of Medicine), Web of Science (Clarivate Analytics), and Scopus (Elsevier) databases using the search terms “ectopic third molar”, “ectopic wisdom tooth”, “maxillary sinus” and “dentigerous cyst”. The retrieved references were exported to the EndNote software (Clarivate Analytics, Philadelphia, USA) to identify and eliminate duplicates.

Articles written in Latin script that mentioned ectopic maxillary third molars in the maxillary sinus, either as case reports or case series, were included in the review. Titles and abstracts of the retrieved references were screened by the authors. If the title or abstract met the inclusion criteria, the full text of the article was reviewed. Articles were excluded if the full text was unavailable. After evaluation of the full texts, only references that satisfied the eligibility criteria were included. Quality assessment and data evaluations were performed by all authors, and any disagreements were resolved through discussion.

For each selected article, the following data were extracted: type of study (case report or case series), sex and age, symptoms, diagnostic method, presence of an associated dentigerous cyst, localization of the ectopic tooth in the sinus cavity, type of anesthesia, surgical treatment, and postoperative complications.

Results

The search of the selected electronic databases revealed 250 references. Of these, 85 papers were selected for full-text evaluation, and 45 articles, reporting 79 cases of MTMMS, met the eligibility criteria [3–47] (**Figure 1**). Detailed characteristics of the studies included in this systematic review are presented in **Table 1**.

Demographic data are summarized in **Table 2**. There were 45 males (58%) and 34 female patients (42%), with a median age of 25.5 years (range 10 to 78

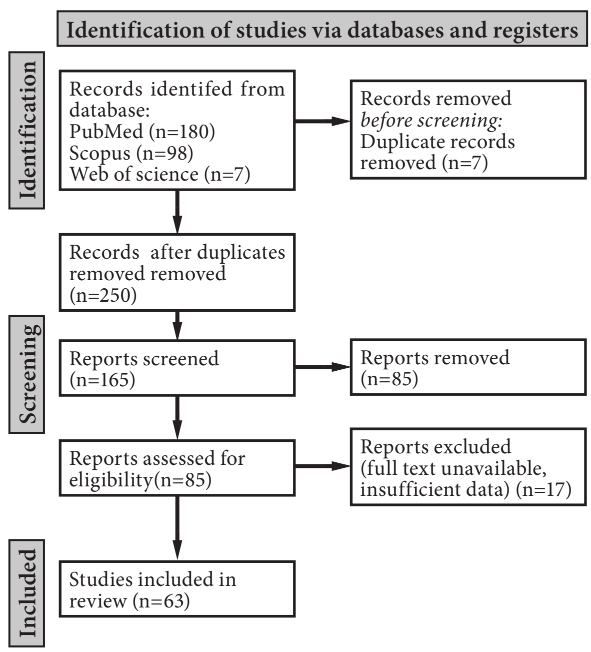

Figure 3. Study inclusion flow chart

Table 1. Publications on maxillary sinus cyst with ectopic third molars

Article	Type of study	Sex/ Age	Symptoms	Imaging	Maxillary sinus cyst	Teeth localization in maxillary sinus	Treatment	Complications
Arici et al. (2022)	Case report	F/32	Pain PR Swelling	CBCT	Dentigerous cyst	Bilateral Superior wall	CL	No
Mavriqi et al. (2022)	Case report	F/38	Pain	CBCT	No	Inferior and posterior wall	Transsinusal extraction and antrostomy + LA	No
El Fattah et al. (2021)	Case series (11 patients)	7M/4F 25-48y	4 asymptomatic 1 proptosis 3 PR + swelling 2 tooth loosening	CT	11 cysts	5 inferior wall 2 medial wall 2 superior wall 1 anterior wall 1 lateral wall	ESS + GA 5 transoral sublabial approach 4 endonasal through middle meatal antrostomy 2 endonasal prelacrimal	No
Lo Faro et al. (2021)	Case report	F/60	UNO PR Facial swelling	CBCT	Dentigerous cyst	Postero superior	CL + GA	No
Sigdel et al. (2021)	Case report	F/10	Facial swelling	CT	Dentigerous cyst	Lateral	CL + intranasal and intraoral endoscopy + GA	No
Seo et al. (2021)	Case series	M/21 F/26 F/65 M/54	Asymptomatic Asymptomatic Tooth loosening Tooth loosening	CT	No	Bilateral posterior Bilateral posterior Posterosuperior Posterosuperior	Modified intraoral endoscopic assisted sinus surgery (MESS)	No
Masalha et al. (2021)	Case series	10 patients 6 M/4 F 16-61 y	7 sinonasal symptoms (UNO, PR, swelling) 2 asymptomatic 1 oroantral fistula	CT	8 dentigerous cysts	1 inferior wall 2 inferior and medial wall 3 superior (orbital floor) 1 anterior 1 lateral	Nasal endoscopy + GA	1 Periorbital emphysema 1 numbness to the cheek 1 Postoperative bleeding
Allen et al. (2020)	Case report	M/14	Asymptomatic	CT	No	Inferior and posterior	Nasal endoscopy + GA	No
AlMomen et al. (2020)	Case report	M	UNO PR Sinusitis	CT	Dentigerous cyst	Medial wall	Transnasal endoscopy + GA	No
Dhivare et al. (2020)	Case report	M/17	Facial swelling Pain	Panoramic	Dentigerous cyst	Superior wall	CL + intranasal and intraoral endoscopy + GA	No
Balaji et al. (2020)	Case report	M/42	Pain	CT	Dentigerous cyst	Superior wall	CL	No
Moldovan et al. (2020)	Case report	F/22	UNO PR	CBCT	Dentigerous cyst	Postero superior	CL + GA	No
Elmorsy et al. (2020)	Case report	F/13	UNO PR	CBCT	Dentigerous cyst	Postero superior	CL + GA	No
Li et al. (2020)	Case series	F/56	Pain PR Swelling	CT	Dentigerous cyst	Posteromedial	CL + intraoral endoscopy + GA	No
		M/21	Pus swelling	CT	Dentigerous cyst	Posteromedial		No
Ngoc et al. (2019)	Case report	M/15	UNO	CBCT	Follicular cyst	Superior	CL	No
Alkhudair et al. (2019)	Case report	M/19	Recurrent sinusitis	CT	Dentigerous cyst	Bilateral ectopic teeth 1 lateral wall 1 medial wall	Nasal endoscopy + GA	No
Bernardi et al. (2018)	Case series	F/16	Exophtalamos Facial swelling Diplopia	CT + MRI	Follicular cysts in sinus and PPF	Posterosuperior wall	CL + intraoral endoscopy + GA	No
		F/20	Facial swelling Diplopia UNO			Posterosuperior wall	CL + intraoral endoscopy + GA	No
Sharma et al. (2019)	Case report	F/27	PR Facial swelling	CBCT	Follicular cyst	Bilaterally ectopic third molars in inferior wall	CL + GA	No
Emanuelli et al. (2018)	Case report	M/40	UNO PR Facial swelling	CT	Follicular cyst	Inferior wall	Nasal endoscopy + GA	No
Lombroni et al. (2018)	Case report	F/37	Asymptomatic	CT	Dentigerous cyst	Inferior and posterior	No	No
Barbieri et al. (2017)	Case report	M/42	PR	CT	Follicular cyst	Superior wall and infraorbital canal	CL + intraoral endoscopy + GA	No
Liau et al. (2017)	Case report	M/63	PR Facial swelling	CBCT	Follicular cyst	Postero superior	CL + endoscopy + GA	No
Marini et al. (2017)	Case report	F/40	UNO PR Facial swelling Headache Trismus	CT	Follicular cyst	Posterosuperior	CL + GA	No

Sinha et al. (2017)	Case report	F/25	UNO PR Facial swelling	CT	Follicular cyst	Superior and medial	CL	No
Jendi et al. (2017)	Case report	F/24	Swelling PR	CT	Odontogenic keratocyst	Lateral	CL + GA	No
Kumar et al. (2016)	Case report	M/22	Pain Headache	CT	Follicular cyst	Posterolateral wall	CL + GA	No
Aydin et al. (2016)	Case report	F/21	Chronic sinusitis Oroantral fistula	CT	Osteoma	Posterior wall	CL + intranasal and intraoral endoscopy + GA	Oroantral fistula
Kara et al. (2015)	Case report	F/16	UNO PR Facial swelling	CT	Follicular cyst	Superior	CL +GA	No
Kayabasoglu et al. (2015)	Case report	F/46	UNO PR Facial swelling	CT	Follicular cyst	Inferior	CL + intraoral endoscopy + GA	No
Bello et al. (2014)	Case report	M/17	UNO PR Facial swelling	CT	No	Posterolateral	CL + GA	No
Demirtas et al. (2014)	Case report	M/19	Pain Blurred vision	CT	Follicular cyst	Superior	CL	No
Mamatha et al. (2014)	Case report	M/17	UNO PR Facial swelling	CBCT	Follicular cyst	Lateral wall	CL + GA	No
Mermod et al. (2014)	Case report	M/74	Pain	CT	No	Posterolateral	CL + GA	No
Sivolella et al. (2014)	Case series	3 M/ 3W 14-65y	5asymptomatic 1 UNO PR	CT	6 dentigerous cysts	5 inferior and lateral 1 superior and lateral	CL + LA	No
Sogur et al. (2014)	Case series	M/19 M/24	Swelling Intraoral pus	CBCT	2 Denigerous cyst	Inferior and medial	CL + LA	No
Datil et al. (2014)	Case report	M/41	UNO PR Swelling	CT	Dentigerous cyst	Posterior and medial	CL + GA	No
Ramanojam et al. (2013)	Case series	F/48 M/22 F/32	Hypoesethesia of infraorbital nerve Asymptomatic Pain	CT CT CT	Dentigerous cyst No No	Inferior Posterior and lateral Anterior and lateral	CL CL + GA CL	Hypoesethesia of infraorbital nerve No No
Abdollahifakhim et al. (2013)	Case report	M/17	UNO PR Facial swelling Headache Halitosis	CT	Follicular cyst	Superior and medial	CL + nasal endoscopy + GA	No
Vidya et al. (2013)	Case report	M/23	Facial pain and swelling	CBCT	Follicular cyst	lateral nasal wall	CL + GA	No
Guruprasad et al. (2013)	Case report	F/21	UNO PR Facial swelling	CT	Follicular cyst	Floor and medial wall	CL + GA	No
Rai et al. (2013)	Case report	F/46	Pain swelling	CT	Follicular cyst	Suerior wall	CL + GA	No
Viterbo et al. (2013)	Case report	M/29	Asymptomatic	CT		Posterior	CL + GA	No
Asnani et al. (2012)	Case report	F/28	UNO PR Facial swelling	CT	Follicular cyst	Superior and medial wall	CL + GA	No
Garde et al (2012)	Case report	M/19	Pain Diplopia	CT	Follicular cyst	Superior	CL + GA	No
Kasat et al (2012)	Case report	M/22	UNO PR Facial swelling	CT	Follicular cyst	Posterosuperior	CL	No
Thakur et al. (2011)	Case report	M/25	Pain	CT	Follicular cyst	Inferior wall	CL + LA	No
Mohan et al. (2011)	Case report	F/28	UNO PR Facial swelling	CT	Follicular cyst	Superior and medial	CL	
Beriat et al. (2011)	Case report	F/24	Pain	CT	Dentigerous cyst	Inferior wall	CL	No
Buyukkurt et al. (2010)	Case series	M/30	Facial swelling	CBCT	Follicular cyst	Posterolateral wall	CL + LA	No
		F/19	Facial swelling	CT	Follicular cyst	Superior and medial wall	CL + LA	No
Prabhu et al. (2009)	Case report	M/14	Facial swelling Pain	CT	Follicular cyst	Superior	CL	No
Lamb et al. (2009)	Case report	M/41	Asymptomatic	CT	Mucocela	Anterior and medial	CL	No
Micozkadioglu et al. (2007)	Case report	F/24	UNO PR Facial swelling Headache	CT	Follicular cyst	Inferior	transnasal endoscopy + GA	No
Prasad et al. (2007)	Case report	M/45	PR Facial swelling	CT	Follicular cyst	Anterior	CL + GA	No

Srinivasa et al. (2007)	Case report	M/45	UNO PR Facial swelling	CT		Anterior	CL + GA	No
Di Pasquale et al. (2006)	Case report	F/14	Asymptomatic	CT	Follicular cyst	Anterior and medial	Nasal endoscopy + GA	No
Buyukkurt et al. (2005)	Case report	M/31	UNO PR Facial swelling Headache	CT	Follicular cyst	Medial wall	CL + LA	No
Kamei et al. (2001)	Case report	F/38	PR	OPG	No cyst	Superior and posterior	CL	No
Hasbini et al. (2001)	Case report	M/21	UNO PR Facial swelling Headache	CT	Follicular cyst	Superior and medial	Endoscopy + GA	No
Bodner et al. (1997)	Case series	F/51 M/25	Asymptomatic Pain	CT	Dentigerous cyst	Inferior and lateral Inferior	CL + GA	No No
Vele et al. (1996)	Case report	M/30	UNO PR Facial swelling	2D	Dentigerous cyst	Posterosuperior wall	CL	No
Meara et al. (1996)	Case report	M/78	UNO PR Facial swelling Headache	CT	Follicular cyst	Posterolateral	CL	Recurrence of cyst after 3 months with oroantral fistula
Funderburg et al. (1992)	Case report	F/18	UNO PR Pain	CT		Posterior	CL + endoscopy + GA	No
Chuong et al. (1984)	Case report	M/16	Halitosis	CT	Follicular cyst	Posteromedial	CL	No
Golden et al. (1981)	Case report	F/37	UNO PR Facial swelling Headache	CT	Follicular cyst	Superior and medial	CL + GA	No
Present Case	Case report	M/13	Intraoral swelling	CBCT	Follicular cyst	Third molar displaced in pterygopalatine fossa	Modified CL + GA	No

M – male; F – female; UNO – unilateral nasal obstruction; PR – purulent rhinorrhea; CT – computed tomography; CBCT – cone beam computed tomography; MRI – magnetic resonance imaging; PPF – pterygopalatine fossa; CL – Caldwell-Luc operation; LA – local anesthesia; GA – general anesthesia

years). The most commonly reported symptoms were pain, swelling, unilateral nasal obstruction, and purulent discharge, while 20% of cases were asymptomatic. Rare symptoms included orbital proptosis, exophthalmos, diplopia, blurred vision, and inferior orbital nerve paresis. In terms of diagnostic imaging, CT was performed in 64 cases (82%), while CBCT was performed in 13 cases (14%). Dentigerous cysts were present in 78% of cases, while rarer findings included osteomas and odontogenic keratocysts associated with ectopic teeth. The most frequent ectopic positions of the third molars within the sinus cavity were in the superior and posterior regions. The conventional Caldwell-Luc approach was utilized in 39 cases (49%), while a modified Caldwell-Luc procedure with intraoral endoscopy was used in 11 (15%) cases. Endoscopic sinus surgery was performed in 29 cases (36%). General anesthesia was administered in 57 cases (71%), while local anesthesia was used in 12 cases (15%) treated with the CL approach. Postoperative outcomes were largely favorable, with 90% of patients experiencing no postoperative complications. However, postoperative sequelae were reported in six cases, including periorbital emphysema, cheek numbness, bleeding, and recurrent oroantral fistula.

Discussion

The most commonly reported surgical procedures for the extraction of ectopic teeth and maxillary sinus cysts in this review were the Caldwell-Luc procedure, endoscopic sinus surgery (ESS), and ESS combined with the Caldwell-Luc approach, accounting for 49%, 15%, and 36% of reports respectively [3–47]. The CL procedure has long been considered the classic surgical approach to the maxillary sinus due to its easy intraoral access to the sinus cavity through canine fossa, which can be performed under local anesthesia. The traditional CL operation involves accessing the sinus cavity through the canine fossa, removing the diseased sinus membrane, and drainage through an artificial aperture on the inferior nasal meatus. However, in the era of endoscopic surgery, the CL approach is considered aggressive due to common complications, including postoperative swelling, infraorbital nerve paresthesia, trauma to adjacent teeth, oroantral fistula, and postoperative anterior maxillary wall defects [1, 2]. In addition, postoperative maxillary cysts may develop years after the CL procedure due to reduced sinus volume [4, 5]. Also, the removal of the entire sinus mucosa during the CL procedure leads to its replacement with non-functional mucosa, permanently altering the physiological functions of the sinus [4, 5]. Further complications may arise when an inferior meatal antrostomy is performed to sinus drainage, such as extended surgery time, nasolacrimal duct injury, and epistaxis [15]. Several modified, less aggressive versions of the CL procedure have been described, omitting the inferior meatotomy operation while still achieving good postoperative outcomes [15]. Endoscopic sinus surgery was introduced as a less invasive technique to traditional sinus surgery, offering reduced risk of damage to tooth roots and the infraorbital nerve, while also promoting sinus function recovery by preserving physiological mucosal lining [12]. In this review, 32% of ectopic third molars in the maxillary sinus were extracted using ESS, with the percentage of reported cases increasing in recent years. Many clinicians consider ESS as the first-line approach for treating maxillary sinus pathologies, especially maxillary sinusitis. However, even in the era of endoscopic surgery, the CL procedure remains the treatment of choice in treating sinusitis with irreversible mucosal damage, oroantral fistulas, odontogenic lesions, orbital floor fracture evaluations, and orbital decompression [1, 2]. Compared to the CL procedure, nasal endoscopy is performed under general anesthesia. Our review found significant differences in both surgical technique and anesthetic procedure. All cases utilizing local anesthesia involved the CL procedure, which may be an advantage of this approach. About 80% of cases were performed under general anesthesia, which although more comfortable for the patient and the surgeon, carries inherent risks. Thus, for situations where local anesthesia in indicated, the CL operation remains the treatment of choice for ectopic teeth in the maxillary sinus.

To reduce the complications associated with the two standard techniques, several authors have reported modifications to these approaches. Li et al. [15] used an endoscopy-assisted CL operation to treat dentigerous cysts and ectopic third molars involving the maxillary sinus, demonstrating that this approach provides clear visibility during operation, less bleeding and nerve injury, minimal incisions, and minimal bone loss. The combination of ESS and CL operation has also been shown to be effective for the removal of foreign bodies in the sinus and even for the enucleation of maxillary sinus tumors such as nasal inverted papilloma. Sigdel et al. [9] proposed a combined endoscopic transantral and endonasal approach for treating large maxillary sinus dentigerous cysts with impacted tooth. El Fattah et al. [4] reported three endoscopic-assisted surgical techniques for managing ectopic maxillary third molars with dentigerous cysts, tailoring the approach based on the location of the ectopic tooth. The authors utilized an endoscopic transoral sublabial approach for managing teeth in the inferior sinus wall, an endoscopy through middle meatal antrostomy for teeth located in the medial and superior walls, and an endonasal pre-lacrimal approach for teeth localized in the anterior wall. All approaches provided excellent visibility, access, and successful outcomes. Seo et al. [5] reported a modified ESS technique that integrates elements of both the conventional Caldwell-Luc procedure and functional endoscopic sinus surgery. This approach includes repositioning the buccal bony window and enlarging the maxillary ostium via an endonasal approach, which enables postoperative reduction of the maxillary sinus resulting from postoperative cyst formation or scar tissues.

Radiological examinations are essential in the preoperative diagnosis and treatment planning for enucleation of ectopic teeth and cysts in maxillary sinus. Conventional panoramic radiographs are useful due to their low level of radiation and diagnostic accuracy for assessing lesions and location of the ectopic tooth [1, 2]. However, 2D panoramic imaging has limitations in interpreting the exact location of the ectopic tooth, especially when displaced in the posterosuperior direction, due to superimposition of different bony structures [1, 2]. Specialized imaging modalities like CT, MRI, and CBCT play a vital role in managing and definitely diagnosing dentigerous cysts involving the maxillary sinus. CBCT offers several advantages over CT and MRI, including multiplanar volume reconstructions, 3D volumetric planning, a significantly lower radiation dose, lower costs, shorter scan times, and fewer imaging artifacts [1]. CBCT is a useful diagnostic tool for evaluating maxillary sinus pathologies due to high sensitivity and specificity for detecting jaw bone pathologies compared with panoramic, CT and MRI.

Regarding the surgical approaches, there were no differences based on the presence of a dentigerous cyst associated with ectopic teeth. Given that dentigerous cyst (DC) are found in about 80% of cases involving ectopic maxillary third molars, differential diagnosis with other cystic radiolucent lesions in the maxillary sinus, such as ameloblastoma (AM) and odontogenic keratocystic tumor (OKC), is essential due to varying treatment approaches for each lesion [48, 49]. Treatment of AM requires radical resection with clear margins and long-term follow-up, while OKC and DC are usually enucleated [49]. Comparative studies of the radiological features of these lesions are well-documented for mandibular lesions, while comparative studies for maxillary lesions remain limited. Meng et al. [49] used CBCT to evaluate the three-dimensional radiological features of maxillary AM, OKC and DC,

Table 2. Summarized data from the assessed articles

Data	Total n (%)	CL	CL + ESS	ESS
Total	105 (100%)	54 (51%)	18 (17%)	33 (32%)
Sex M/F	60 /45	32 /22	7/9	18/10
Age	31.21 ± 15.00	32.43±17.87	35.23±11.21	30.11±15.23
Symptoms				
Asymptomatic	21 (20%)	10 (18%)	5 (27%)	11 (30%)
Swelling	53 (52%)	33 (61%)	10 (59%)	14 (43%)
Pain	19 (16%)	11 (23%)	4 (23%)	11 (33%)
PR	52 (45%)	16 (31%)	7 (42%)	13 (40%)
UNO	35 (33%)	21 (41%)	6 (34%)	11 (33%)
Headache	15 (10%)	5 (11%)	3 (18%)	3 (9%)
Radiological diagnosis				
2D	2 (2%)	1 (2%)	1 (6%)	0
CT	86 (82%)	39 (72%)	14 (88%)	28 (100%)
CBCT	15 (14%)	14 (26%)	1 (6%)	0
CT + MRI	2 (2%)	0	0	0
Dentigerous cyst				
Yes	80 (76%)	45 (83%)	12 (66%)	25 (75%)
No	23 (22%)	8 (15%)	6 (34%)	7 (22%)
Other				
Osteoma	1 (1%)	1 (2%)	-	-
OKC	1 (1%)	-	-	1 (3%)
Position of the tooth in the sinus				
Superior	35 (33%)	16 (24%)	6 (33%)	10 (31%)
Posterior	17 (15%)	10 (21%)	9 (50%)	1 (3%)
Inferior	21 (20%)	11 (22%)	1 (4%)	11 (33%)
Lateral	11 (12%)	6 (11%)	1 (4%)	4 (11%)
Medial	11 (12%)	5 (10%)	1 (4%)	4 (11%)
Anterior	9 (8%)	6 (11%)	0	4 (11%)
Anesthesia				
Local	12 (11%)	12 (22%)	0	0
General	75 (71%)	29 (54%)	16 (100%)	28 (100%)
Unknown	18 (17%)	13 (24%)	0	0
Complications				
Yes	6 (6%)	2 (4%)	1 (6%)	3 (11%)
No	94 (90%)	52 (96%)	15 (94%)	25 (89%)
Unknown	5 (4%)	0	0	0

UNO – unilateral nasal obstruction; PR – purulent rhinorrhea; CT – computed tomography; CBCT – cone beam computed tomography; MRI – magnetic resonance imaging; CL – Caldwell-Luc operation; ESS – endoscopic sinus surgery; OKC – odontogenic keratocyst

and they identified significant differences among these lesions in terms of selected radiological features, such as radiopacity, location, size, bone expansion, internal structure, external borders, tooth envelopment, and tooth resorption. AM typically presents in the posterior maxilla, predominantly as oval shaped, unilocular or honeycombed internal structure with scalloped borders, and is frequently associated with adjacent tooth displacement and root resorption. OKC, by contrast, appears predominantly in the posterior maxilla as radiolucent, irregularly shaped lesion, with smooth borders and unilocular or multilocular internal structure, often enveloping adjacent teeth. OKC has higher tendency to fill the entire maxillary sinus compared to AM and DC. DC typically presents as an oval, radiolucent lesions with smooth borders and enveloped teeth.

This review identified significant differences in the location of ectopic teeth within the maxillary sinus and the choice of surgical technique. It appears that the CL procedure was preferred for teeth positioned in superior and posterosuperior locations, likely due to its good visualization and access to the posterior and superior walls of the maxillary sinus. Three-dimensional reconstruction of tooth localization is important in treatment planning. It is worth noting that ESS was used for the treatment of superiorly and posterosuperiorly positioned teeth in nine cases without any intraoperative or postoperative complications. Therefore, the observed differences in the choice of technique may be explained by the individual skills of the surgeon.

Conclusion

Based on the extensive literature review, we can conclude that the Caldwell-Luc procedure remains the preferred treatment for the removal of ectopic teeth associated with the maxillary sinus, with or without the presence of dentigerous cysts. However, recent reports on the use of endoscopic sinus surgery for the removal of ectopic teeth favor this less invasive approach. Special should be given to further modifications of intraoral endoscopy in combination with the Caldwell-Luc technique, which may become the gold standard for this intervention.

References

1. Brajkovic D, Kiralj A, Ilic M, Mijatov I, Mijatov S. Surgical treatment of dentigerous cyst and ectopic maxillary molars involving maxillary sinus: a case report. Med Pregl. 2024;77(5-6):183-6.
2. Courtot R, Devoize L, Louvrier A, Pereira B, Caillet J, Meyer C, et al. Surgical approach of ectopic maxillary third molar avulsion: systematic review and meta-analysis. J Stomatol Oral Maxillofac Surg. 2021;122(1):77-82.
3. Buyukkurt MC, Omezli MM, Miloglu O. Dentigerous cyst associated with an ectopic tooth in the maxillary sinus: a report of 3 cases and review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(1):67-71.
4. Abd El-Fattah AM, Khafagy YW, El-Sisi H, Elkahwagi M, Ebada HA. Ectopic maxillary sinus third molar with dentigerous cyst in 11 patients: tailored endoscopic-assisted approaches for a successful outcome. Clin Otolaryngol. 2021;46(5):1095-9.
5. Seo MH, Lee JY, Frimpong P, Eo MY, Kim SM. Modified endoscopic-assisted approach for removal of ectopic third molar in the maxillary sinus. Appl Sci (Basel). 2021;11(18):8446.
6. Arici M, Bayar T, Tas-Ozyurtseven B, Gungormus M. Bilateral ectopic third molars in maxillary sinus associated with dentigerous cyst identified with ophthalmic, nasal and maxillary complication: a rare case report. J Oral Maxillofac Pathol. 2022;26 (Suppl 1):S84-7.
7. Mavriqi L, Lorusso F, Tartaglia G, Inchingolo F, Scarano A. Transinusal pathway removal of an impacted third molar with an unusual approach: a case report and a systematic review of the literature. Antibiotics (Basel). 2022;11(5):658.
8. Lo Faro C, Santillo V, Lo Giudice G, Troiano A, Montella M, D Amato S, et al. Large follicular cyst associated with upper third molar in the maxillary sinus with pterygomaxillary space extension: reflection on a case report. Open Access Maced J Med Sci. 2021;9(C):16-9.
9. Sigdel B, Sah K, Kandel D, Karn M, Moran A, Panta A. Endoscopic-assisted transantral-endonasal approach to large dentigerous cyst of maxillary sinus. Clin Case Rep. 2021;9(10):e05027.
10. Masalha M, Schneider S, Kassem F, Koren I, Eliashar R, Margulis A, et al. Endoscopic treatment of ectopic teeth in the maxillary sinus. J Clin Exp Dent. 2021;13(3):e227-33.
11. Allen DZ, Sethia R, Hamersley E, Elmaraghy CA. Presentation of an iatrogenically displaced third molar into the maxillary sinus in a 14-year-old patient successfully removed with an endoscopic approach: a case report and a review of the literature. J Surg Case Rep. 2020;2020(10):rjaa290.
12. Almomen A, Alkhudair B, Alkhatib A, Alazzah G, Ali Z, Al Yaeesh I, et al. Ectopic maxillary tooth as a cause of recurrent maxillary sinusitis: a case report and review of the literature. J Surg Case Rep. 2020;2020(9):rjaa334.
13. Moldovan MA, Rotaru H, Roman CR. Giant follicular cyst with maxillary sinus and pterygomaxillary space extension. Ann Ital Chir. 2020;9:S2239253X20032983.
14. Elmorsy K, Elsayed LK, El Khateeb S. Case report: ectopic third molar in the maxillary sinus with infected dentigerous cyst assessed by cone beam CT. F1000Res. 2020;9:209.
15. Li SH, Wang Y, Huang ZX, Jin TT, Huang ZQ. Endoscope-assisted surgery in the treatment of dentigerous cyst involving the maxillary sinus - report of two cases. Chin J Dent Res. 2020;23 (1):71-6.
16. Bernardi S, Scarsella S, Di Fabio D, Oliva A, Di Girolamo M, Continenza MA, et al. Giant follicular cysts extended in pterygo-maxillary fossa, antro-naso-ethmoidal and orbital space associated to exophtalmos and diplopia in young patients. Oral Maxillofac Surg Cases. 2018;4(1):17-22.
17. Sharma S, Chauhan JS. Bilateral ectopic third molars in maxillary sinus associated with dentigerous cyst - a rare case report. Int J Surg Case Rep. 2019;61:298-301.
18. Emanuelli E, Borsetto D, Brunello G, Sivolella S. Endoscopy-assisted removal through combined lower and middle meatotomies of an ectopic upper third molar in the sinus associated with a dentigerous cyst. Oral Maxillofac Surg Cases. 2018; 4(1):23-31.
19. Barbieri D, Cappare P, Gastaldi G, Trimarchi, M. Ectopic tooth involving the orbital floor and infraorbital nerve. Journal of Osseointegration. 2017;9(4):323-5.
20. Liau I, Lynch N, Hearn B, Cheng A. Endoscopically assisted modified Caldwell-Luc approach to enucleation of dentigerous cyst with ectopic tooth from the maxillary sinus. J Craniofac Surg. 2018;29(6):e568-70.
21. Marini E, Marini L, Messina AM. Treatment of giant maxillary dentigerous cyst and ectopic third molar with piezoelectric surgery. Italian Journal of Dental Medicine. 2017;2:131-6.
22. Jendi SK. Ectopic third molar: a hidden cause for maxillary sinusitis - a rare case report. Indian J Otolaryngol Head Neck Surg. 2019;71(Suppl 1):831-4.
23. Kumar A, Srivastava RK, Saxena A, Khanna R, Ali I. Removal of infected maxillary third molar from the infra-temporal fossa by Caldwell Luc procedure – rare case report with literature review. J Clin Diagn Res. 2016;10(12):ZD01-3.
24. Aydin U, Asik B, Ahmedov A, Durmaz A. Osteoma and ectopic tooth of the left maxillary sinus: a unique coexistence. Balk Med J. 2016;33(16):473-6.
25. Kara MI, Yanik S, Altan A, Oznalcin O, Ay S. Large dentigerous cyst in the maxillary sinus leading to diplopia and nasal obstruction: case report. J Istanb Univ Fac Dent. 2015;49(2):46-50.
26. Kayabasoglu G, Karaman M, Kaymaz R, Nacar A. A rare entity causing chronic snusitis: ectopic tooth in maxillary sinus. European Journal of General Medicine. 2015;12(1):86-9.
27. Bello SA, Oketade IO, Osunde OD. Ectopic 3rd molar tooth in the maxillary antrum. Case Rep Dent. 2014;2014:620741.
28. N S M, Krishnamoorthy B, J K S, Bhai P. Diagnostic CBCT in dentigerous cyst with ectopic third molar in the maxillary sinus-a case report. J Clin Diagn Res. 2014;8(6):ZD07-9.
29. Sivolella S, Ricci S, Busca M, Stellini E, Valente M. Maxillary dentigerous cyst associated with an ectopic third molar in the maxillary sinus: a literature review and report of six consecutive cases. Oral Surg. 2014;7(Suppl 1):72-8.
30. Sogur E, Özden M, Günbay T, Tugsel Z. Cone beam computed tomography findings of ectopic tooth in the maxillary sinus associated with dentigerous cyst: a report of two cases and review of the literature. Journal of Oral and Maxillofacial Radiology. 2015;3(2):70-5.
31. Ramanojam S, Halli R, Hebbale M, Bhardwaj S. Ectopic tooth in maxillary sinus: case series. Ann Maxillofac Surg. 2013; 3(1):89-92.

32. Abdollahifakhim S, Mousaviagdas M. Ectopic molar with maxillary sinus drainage obstruction and oroantral fistula. Iran J Otorhinolaryngol. 2013;25(72):187-92.

33. Vidya L, Ranganathan K, Praveen B, Gunaseelan R, Shanmugasundaram S. Cone-beam computed tomography in the management of dentigerous cyst of the jaws: a report of two cases. Indian J Radiol Imaging. 2013;23(4):342-6.

34. Guruprasad Y, Chauhan DS, Kura U. Infected dentigerous cyst of maxillary sinus arising from an ectopic third molar. J Clin Imaging Sci. 2013:3(Suppl 1):7.

35. Rai A, Rai NJ, Rai MA, Jain G. Transoral removal of ectopic maxillary third molar situated superiorly to maxillary antrum and posteroinferiorly to the floor of orbit. Indian J Dent Res. 2013;24(6):756-8.

36. Viterbo S, Griffa A, Boffano P. Endoscopic removal of an ectopic tooth in maxillary sinus. J Craniofac Surg. 2013;24(1):e46-8.

37. Garde JB, Kulkarni AU, Dadhe D. Ectopic tooth in the orbital floor: an unusual case of dentigerous cyst. BMJ Case Rep. 2012;2012:bcr1120115266.

38. Kasat VO, Karjodkar FR, Laddha RS. Dentigerous cyst associated with an ectopic third molar in the maxillary sinus: a case report and review of literature. Contemp Clin Dent. 2012;3(3):373-6.

39. Thakur G, Nair PP, Thomas S, Ahuja R, Kothari P. Dentigerous cyst associated with ectopic maxillary third molar in maxillary antrum. BMJ Case Rep. 2011;2011:bcr0220113873.

40. Beriat GK, Beriat NC, Yalcinkaya E. Ectopic molar tooth in the maxillary sinus. A case report. Clinical Dentistry Research. 2011;35(2):35-40.

Rad je primljen 17. IV 2024.
Recenziran 4. X 2024.
Prihvaćen za štampu 4. X 2024.
BIBLID.0025-8105:(2024):LXXVII:7-8:248-256.

41. Prabhu SP, Padwa BL, Robson CD, Rahbar R. Dentigerous cyst associated with a displaced tooth in the maxillary sinus: an unusual cause of recurrent sinusitis in an adolescent. Pediatr Radiol. 2009;39(10):1102-4.

42. Lamb JF, Husein OF, Spiess AC. Ectopic molar in the maxillary sinus precipitating a mucocele: a case report and literature review. Ear Nose Throat J. 2009;88(8):E6-11.

43. Di Pasquale P, Shermetaro C. Endoscopic removal of a dentigerous cyst producing unilateral maxillary sinus opacification on computed tomography. Ear Nose Throat J. 2006;85(11):747-8.

44. Bodner L, Tovi F, Bar-Ziv J. Teeth in the maxillary sinus – imaging and management. J Laryngol Otol. 1997;111(9):820-4.

45. Vele DD, Sengupta SK, Dubey SP, Dokup MK. Cystic lesions of the nasal cavity and the paranasal sinuses: report of two unusual cases. J Laryngol Otol. 1996;110(12):1157-60.

46. Meara JG, Brown MT, Caradonna D, Varvares MA. Massive, destructive, dentigerous cyst: a case report. Otolaryngol Head Neck Surg. 1996:115(1):141-4.

47. Funderburg JC. Endoscopic extraction of an ectopic third molar. Mil Med. 1992:157(8):431-2.

48. Mijatov I, Kiralj A, Vučković N, Nikolić J, Tadić A, Mijatov S. Preoperative determination of tumor thickness in oral squamous cell carcinoma by computed tomography. Med Pregl. 2022;75(11-12):338-43.

49. Meng Y, Zhao YN, Zhang YQ, Liu DG, Gao Y. Three-dimensional radiographic features of ameloblastoma and cystic lesions in the maxilla. Dentomaxillofac Radiol. 2019;48(6):20190066.