Postoperative Complications Following Cystectomy in Children: A Review of Current Literature

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Abstract

Objective — To systematize current literature data on the frequency, types and mechanisms of postoperative complications in children following jaw cystectomy, as well as to identify avenues for their prevention.

Materials and Methods — An analysis was conducted of more than 70 domestic and international publications (PubMed, eLibrary, Scopus) from 2010–2025 dedicated to the treatment of odontogenic cysts in children. Data on cyst types, surgical techniques (cystectomy, cystotomy, combined methods), patient age and the nature of complications were considered.

Results — The frequency of complications following cystectomy in children varies between 10 % and 25 %. The most common complications are inflammatory reactions, maxillary sinus perforation, damage to the permanent tooth germs and cyst recurrence. The risk of complications increases with larger cysts, delayed presentation and inadequate antiseptic management.

Conclusion — Prevention of complications after cystectomy in children requires an individualized choice of treatment modality taking into account age, anatomy and stage of tooth development, use of minimally invasive technologies and biomaterials for bone defect reconstruction.

Keywords: cystectomy, children, odontogenic cysts, complications, maxillofacial surgery, pediatric dentistry, bone grafting, prevention.

Introduction

Jaw cysts in children belong to the most common cystic lesions of the facial skeleton and account for, according to various data, between 8 % and 15 % of all maxillofacial disorders. Among them, radicular and follicular cysts predominate,

arising against the background of chronic inflammatory processes in the periapical region of deciduous teeth and maldevelopment of permanent tooth germs.

The standard treatment method is cystectomy — complete removal of the cystic sac together with its epithelial lining. However, in paediatric patients, performing radical surgical interventions is associated with a number of difficulties: thin bone, close proximity of permanent tooth germs, limited tissue regenerative capacity and increased reactivity of the oral mucosa.

These features determine a high risk of postoperative complications, which may manifest as inflammation, damage to tooth germs, deformation of the alveolar process, impaired osteogenesis and cyst recurrence.

The objective of the present work is to carry out a systematic analysis of current literature data on the structure and frequency of complications after cystectomy in children and to determine key directions for prevention.

Materials and Methods

For the analysis, publications from the databases PubMed, Scopus, Web of Science, eLibrary and leading dental journals from the period 2010–2025 were used. The search was performed using keywords: “jaw cystectomy”, “pediatric odontogenic cyst”, “postoperative complications”, “oral surgery in children”, “PRF”, “laser cystectomy”.

The review included publications containing clinical observations or aggregated data on outcomes of surgical treatment of jaw cysts in children.
Inclusion criteria: patients aged up to 18 years; clear description of surgical method (cystectomy or combined techniques); specification of complications and follow-up periods.
Exclusion criteria: single clinical case reports without statistical analysis; studies involving only adult patients; publications lacking postoperative follow-up data.

Results

1. Frequency and Structure of Complications

Table 1. Frequency and structure of postoperative complications after cystectomy in children.

Type of complication	Frequency (literature data)	Clinical manifestations	Main risk factors
Inflammatory (alveolitis, periostitis, osteomyelitis)	12–15 %	Swelling, pain, hyperemia, exudation	Infection, poor debridement, traumatic surgery
Maxillary sinus perforation	5–8 %	Sinus communication, sinusitis	Maxillary cysts, aggressive curettage
Damage to permanent tooth germs	8–10 %	Delayed eruption, root deformation	Proximity of deciduous and permanent teeth
Impaired osteogenesis	7–9 %	Delayed healing, bone defects	Large cyst size, absence of bone grafting
Cyst recurrence	6–8 %	Reformation of the cavity	Incomplete capsule removal, residual infection

According to systematic reviews (Ivanova et al., 2019; Chrcanovic, 2020), the incidence of postoperative complications after cystectomy in children ranges from **10 % to 25 %.** The most common are: inflammatory reactions (12–15 %), maxillary sinus perforation (5–8 %), injury to permanent tooth germs (8–10 %), disturbances of osteogenesis (7–9 %), and cyst recurrence (6–8 %).

2. Inflammatory Complications

The most frequent postoperative issue is **alveolitis** and inflammation of the surgical cavity. Etiologic factors include insufficient debridement, residual cystic capsule infection, traumatic extraction, and inadequate antiseptic care.

In children, inflammation often develops acutely, with pronounced edema and pain. Without timely intervention, it may progress to periostitis or osteomyelitis.

3. Injury to Tooth Germs and Bone Structures

Because of the close proximity of primary and permanent teeth—especially between ages 6 and 9—there is a risk of trauma or displacement of developing tooth germs. This can result in delayed eruption, root malformation, or resorption. Large cysts in the premolar and molar regions may cause **alveolar ridge deformation**, complicating future orthodontic treatment.

4. Maxillary Sinus Perforation

During removal of cysts of the upper jaw, perforation of the maxillary sinus frequently occurs. According to Bataineh (2021), the incidence reaches 8 %. In most cases, the defect closes spontaneously; however, if sanitation is inadequate, **sinusitis** or **oroantral communication** may develop, sometimes requiring surgical repair.

5. Recurrence and Impaired Osteogenesis

Cyst recurrence typically occurs after incomplete removal of the capsule or when secondary infection is present. Impaired osteogenesis manifests as delayed bone healing and fibrous cavity formation.
Use of osteoplastic materials such as **hydroxyapatite**, **β-TCP**, and **PRF gel** significantly reduces these risks.

Pathogenesis of Complications

The pathogenesis of postoperative complications following cystectomy in children is multifactorial, involving inflammatory, vascular, and osteoregenerative mechanisms. Inflammatory reactions are driven by activation of pro-inflammatory cytokines (IL-1β, IL-6, TNF-α), increased vascular permeability, and microbial contamination of the surgical site. Delayed osteogenesis results from decreased osteoblastic activity and insufficient expression of growth factors (VEGF, BMP-2, TGF-β).
In children, regenerative processes are unstable, requiring strict adherence to biological principles of wound healing and minimization of tissue trauma.

Discussion

The analysis demonstrates that postoperative complications after pediatric cystectomy are predominantly **inflammatory-traumatic** and **regenerative** in nature.

Key risk factors include **late diagnosis**, **large cyst size**, **close proximity of tooth germs**, **lack of atraumatic technique**, and **insufficient postoperative supervision**.

Modern surgical strategies emphasize a shift from radical to **minimally invasive microsurgical approaches**. The use of **operating microscopes**, **piezosurgery**, **ultrasonic instruments**, and **biomaterials** markedly decreases tissue trauma and accelerates bone repair. Particular attention is given to the prevention of inflammatory complications through appropriate antiseptic preparation, short-term antibiotic therapy, **laser treatment**, and **photodynamic disinfection**.

Multidisciplinary management involving a **pediatric dentist, orthodontist, and pediatrician** remains essential—especially for patients with occlusal deformities or chronic oral infections. According to Lee et al. (2023), comprehensive preventive measures combining micro-invasive techniques and PRF-based therapy reduce the complication rate by more than 30 % compared with conventional methods.

Comparison with International Protocols (EAOMS, AAPD, ESPD)

The guidelines of **EAOMS (2023)**, **AAPD (2022)**, and **ESPD (2024)** recommend that cyst surgery in children be as **organ-preserving** as possible, prioritizing **early diagnosis** and **minimal trauma**. International protocols emphasize:
– use of **piezosurgery** and **laser systems** to minimize damage to tooth germs;
– application of **autologous biomaterials** (PRF, PRP) to enhance bone regeneration;
– **restriction of systemic antibiotic prophylaxis** when no infection is present;
– mandatory **radiological and clinical follow-up** every 3–6 months.

In domestic pediatric practice these standards are gradually being implemented, though unified clinical guidelines are still lacking—highlighting the need for harmonization with international experience.

Clinical and Anatomical Features of Childhood

The jawbone in children exhibits a **highly cancellous structure**, a **thin cortical layer**, and **rich vascularization**. While these features support rapid regeneration, they also increase the risk of **bleeding, edema, and injury to developing tooth germs**. Growth zones and actively forming follicles of permanent teeth are particularly sensitive to mechanical stress, necessitating the use of **atraumatic instruments**, such as ultrasonic and piezosurgical systems, to prevent iatrogenic injury.

Clinical and Anatomical Features of Childhood

The pediatric jawbone is characterized by a pronounced cancellous structure, a thin cortical layer, and rich vascularization. These features, on the one hand, promote rapid regeneration, but on the other hand, increase the risk of bleeding, edema, and injury to developing tooth germs. Growth zones and actively forming follicles of permanent teeth are especially sensitive to mechanical stress, which requires the use of **atraumatic instruments**, such as ultrasonic and piezosurgical systems.

Modern Directions in the Prevention of Complications

The prevention of complications should be based on the principles of **biologically guided healing**:

Laser closure of bone cavities (Er:YAG and diode lasers) promotes coagulation and sterilization of cyst walls.

PRF membranes provide the gradual release of growth factors (PDGF, TGF-β, VEGF) and accelerate osteogenesis.

Collagen and β-TCP matrices create an osteoconductive framework and reduce the risk of alveolar ridge deformation.

Early physiotherapy (low-intensity laser therapy, magnetotherapy) decreases inflammation and improves microcirculation.

Thus, the modern strategy for preventing complications after pediatric cystectomy combines **minimally invasive techniques**, **regenerative technologies**, and a **multidisciplinary approach**.

Algorithm for the Prevention of Complications

Effective prevention of complications includes three key stages:

1. **Preoperative stage:** sanitation of chronic infection foci, CT-based surgical planning, assessment of anatomical risks, and psychological preparation of the child.
2. **Intraoperative stage:** use of microsurgical instruments, PRF/PRP membranes, laser exposure, and gentle irrigation and aspiration modes.
3. **Postoperative stage:** maintenance of oral hygiene, use of photodynamic therapy and physiotherapeutic procedures, and radiographic follow-up at 3–6 months.

Such an approach shortens the healing period and reduces the incidence of complications by **25–30 %** compared with traditional methods.

Limitations of the Review

The present review is limited by the heterogeneity of the included studies, variations in cyst classification, duration of follow-up, and patient age groups. Most publications are based on retrospective data and small sample sizes, which may reduce the accuracy of estimating complication rates. Further **prospective, multicenter studies** with unified outcome criteria are needed to validate these findings.

Conclusion

Postoperative complications following cystectomy in children remain a relevant problem in pediatric oral and maxillofacial surgery. The most frequent complications are inflammatory reactions, maxillary sinus perforation, damage to tooth germs, and disturbances of osteogenesis. Reduction of complications is achievable through the use of **micro-invasive technologies**, **PRF- and laser-assisted methods**, **osteoplastic materials**, and **strict aseptic technique**.

Comparison of domestic and international approaches highlights the need to transition toward **unified clinical protocols** based on EAOMS, AAPD, and ESPD principles.

Early diagnosis, personalized surgical planning, and active postoperative follow-up ensure anatomical and functional restoration of the jaw and a high level of pediatric dental rehabilitation.

Future Research Perspectives

Promising directions for further investigation include: development of standardized criteria for assessing postoperative complications in pediatric oral and maxillofacial surgery; evaluation of the impact of **PRF-based and biomaterial technologies** on age-dependent osteoregeneration; creation of **combined laser-piezosurgical protocols** in accordance with EAOMS and AAPD recommendations.

Integration of these approaches will improve the quality of pediatric dental care and reduce the incidence of complications after cystectomy in children.

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