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PIEZOELECTRIC VS. CONVENTIONAL TECHNIQUES IN PEDIATRIC ORAL SURGERY: A NARRATIVE REVIEW OF CLINICAL OUTCOMES IN PRIMARY AND EARLY THIRD MOLAR EXTRACTIONS

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ABSTRACT

Background: Pediatric oral surgery aims to minimize trauma, reduce pain, and preserve developing structures. Piezoelectric surgery, an ultrasonic bone-cutting technique, has been proposed as an alternative to conventional rotary instruments.

Objective: To synthesize existing evidence comparing piezoelectric and conventional approaches in pediatric oral surgery, focusing on clinical outcomes in primary and early third molar extractions.

Summary: Evidence indicates that piezosurgery reduces intraoperative bleeding, postoperative pain, swelling, and accelerates recovery. Operative time is consistently longer compared with rotary techniques. Pediatric-specific data are limited but suggest advantages in comfort, safety near developing tooth buds, and faster functional return.

Conclusion: Piezoelectric surgery offers promising clinical benefits in children but requires validation through high-quality pediatric trials before routine adoption.

INTRODUCTION

Tooth extractions are among the most common surgical procedures in pediatric dentistry and oral and maxillofacial practice. They are carried out for a range of indications, including the removal of retained or ankylosed primary teeth, extraction of carious teeth beyond restoration, management of supernumerary teeth, and prophylactic removal of early-developing third molars to prevent impaction or pathologic sequelae. Because these procedures are performed in children and adolescents, the primary goals extend beyond immediate surgical success. Clinicians must also minimize operative trauma, preserve the integrity of developing permanent dentition, limit perioperative pain and swelling, and promote rapid return to function. Achieving these objectives is critical not only for oral health but also for the overall well-being and cooperation of the pediatric patient, who may experience heightened anxiety and reduced tolerance for prolonged or traumatic interventions.

For decades, conventional rotary instruments such as burs, drills, and oscillating saws have been the mainstay of pediatric oral surgery. These devices are valued for their cutting efficiency, availability, and familiarity to clinicians. However, their use is not without drawbacks. Rotary instruments cut indiscriminately through hard and soft tissues alike, posing risks to adjacent anatomical structures such as nerves, blood vessels, and developing permanent tooth buds. The mechanical friction generated during rotary osteotomy produces heat, which can cause thermal necrosis of bone and compromise socket healing. Soft tissue lacerations, excessive intraoperative bleeding, and postoperative morbidity—particularly pain, swelling, and trismus—are frequent challenges. These drawbacks are especially concerning in the pediatric population, where smaller anatomical structures, limited patient cooperation, and the presence of developing dentition amplify the risk of complications.

In the late 20th century, piezoelectric surgery was introduced as a novel bone-cutting technique designed to overcome many of these limitations. First described in 1988 by Vercellotti, the method employs ultrasonic microvibrations to cut mineralized tissue selectively. The technology is based on the piezoelectric effect, whereby certain crystals deform when exposed to an electric field, generating ultrasonic vibrations. These oscillations, typically in the range of 25–30 kHz, are transmitted to specialized tips that cut through mineralized bone with micrometric precision while sparing adjacent soft tissues such as nerves, vessels, and mucosa. The cavitation effect produced in the surgical field further enhances visibility by reducing bleeding, as the ultrasonic energy promotes coagulation and clears the operative site with microbubbles.

The technological characteristics of piezosurgery confer several clinical advantages. Unlike rotary burs, piezoelectric devices require less apical pressure, thereby reducing operator fatigue and minimizing the risk of uncontrolled movements. The selective action on mineralized tissue allows for safer bone removal in close proximity to critical structures, such as unerupted permanent successors, neurovascular bundles, or the maxillary sinus. In addition, ultrasonic cutting is associated with reduced heat generation compared with high-speed rotary instruments, lowering the risk of thermal injury to bone and surrounding tissues. Patients often experience less intraoperative trauma, reduced postoperative pain and swelling, and faster mucosal healing. These outcomes align closely with the goals of minimally invasive pediatric oral surgery.

The scope of piezosurgery in oral and maxillofacial practice has broadened considerably since its inception. Initially applied in implantology and adult orthognathic surgery, it has more recently been adapted for pediatric indications, including extraction of primary teeth, exposure of impacted canines, removal of

early third molars, and management of ankylosed or supernumerary teeth. Case reports and small clinical series highlight its safety and efficacy in children, particularly in complex situations where conventional rotary techniques carry heightened risks. For example, in cases of ankylosed primary teeth adjacent to developing permanent buds, piezoelectric devices enable precise removal with minimal collateral trauma. Similarly, in the surgical extraction of early-developing third molars, piezosurgery has been shown to reduce postoperative morbidity, thereby facilitating quicker return to normal feeding and daily activities—an important outcome in the pediatric context.

Nevertheless, the adoption of piezoelectric surgery in children is not without challenges. The most frequently cited drawback is increased operative time, with studies reporting an additional 5 to 15 minutes per extraction compared with rotary instruments. While this difference is often modest, it may become clinically relevant in younger or less cooperative children, for whom prolonged procedures can heighten anxiety and movement. Furthermore, the cost of piezoelectric units and their specialized tips is higher than conventional equipment, potentially limiting accessibility in resource-constrained environments. From a training standpoint, a learning curve exists, and practitioners require familiarity with tip selection, pressure modulation, and irrigation protocols to maximize the benefits of the technology.

The evidence base for piezosurgery in pediatric oral surgery remains evolving. While numerous randomized controlled trials, systematic reviews, and meta-analyses have compared piezoelectric and rotary approaches in adult or mixed-age populations undergoing third molar surgery, data specifically focused on children and adolescents are relatively sparse. Many pediatric studies are limited to case reports, small case series, or pilot trials, with heterogeneity in study design and outcome measures. Long-term outcomes, such as preservation of alveolar bone for orthodontic purposes or the effect on eruption of permanent successors, remain understudied. Despite these limitations, the available data suggest that piezoelectric surgery may offer superior comfort, enhanced safety near developing structures, and faster recovery compared with conventional rotary methods.

The rationale for this review lies in the need to consolidate and critically assess the current evidence comparing piezoelectric and conventional techniques in pediatric oral surgery. By synthesizing findings from clinical studies, case reports, and systematic analyses, we aim to clarify the relative advantages and limitations of piezosurgery in children. Particular emphasis is placed on operative time, intraoperative bleeding, postoperative pain and swelling, healing outcomes, and safety in relation to developing dentition. Understanding these factors is essential for informing clinical decision-making, guiding patient and parent counseling, and identifying areas where further high-quality research is required.

In summary, the evolution of surgical techniques in pediatric oral surgery reflects a shift toward minimally invasive, patient-centered approaches that prioritize comfort, safety, and functional preservation. Piezoelectric surgery, with its selective cutting properties and favorable healing profile, represents a promising advancement in this context. Yet, despite encouraging preliminary evidence, questions remain regarding its routine adoption in pediatric practice. Through this review, we seek to evaluate the comparative clinical outcomes of piezoelectric and conventional rotary approaches, highlight the specific relevance to children and adolescents, and outline future directions for research and clinical application.

DISCUSSION

This review highlights the potential role of piezoelectric surgery as a minimally invasive alternative to conventional rotary instruments in pediatric oral surgery. Across studies, piezosurgery consistently

demonstrated reductions in intraoperative bleeding, postoperative pain, and swelling, with added safety in proximity to developing tooth buds and neurovascular structures. These findings align with the broader principles of pediatric surgery, where minimizing trauma and expediting recovery are central goals.

Clinical Advantages in Pediatrics

The most consistent advantage of piezosurgery is its selective cutting ability, which spares soft tissues and provides enhanced operative visibility. In children, where limited cooperation and smaller anatomical spaces complicate surgical procedures, improved control and reduced bleeding can significantly facilitate the procedure. Moreover, several reports indicate that children treated with piezoelectric techniques resume normal eating and school attendance earlier than those treated with rotary instruments, underscoring its value in enhancing postoperative quality of life.

Postoperative Morbidity and Recovery

Pain and swelling remain major concerns following pediatric extractions, especially in younger children with lower pain thresholds. The reviewed studies consistently demonstrate lower pain scores and reduced edema within the first 72 hours following piezoelectric third molar or premolar extractions. Faster mucosal healing and improved socket preservation may also have long-term benefits for alveolar development and orthodontic planning, although robust longitudinal data are lacking.

Limitations of Piezosurgery

Despite these advantages, the prolonged operative time remains a notable limitation. An additional 5–15 minutes may be clinically acceptable in cooperative adolescents, but can be problematic in younger children with limited tolerance for surgical stress. For anxious or special needs patients, this limitation may necessitate adjunctive behavior management or sedation strategies. Cost also poses a barrier: piezoelectric units and tips are substantially more expensive than conventional rotary instruments, which may restrict access in low-resource settings. Furthermore, a learning curve exists; clinicians unfamiliar with the technology may initially experience greater inefficiency until adequate proficiency is gained.

Evidence Gaps

A major limitation of the current evidence is the scarcity of pediatric-specific randomized controlled trials. Most comparative studies derive from mixed-age cohorts, particularly in the context of third molar extractions, with only a small number focusing exclusively on children. Case series and pilot studies suggest distinct advantages in ankylosed primary teeth or extractions near unerupted successors, but these observations require validation through controlled designs. Additionally, little is known about long-term outcomes such as alveolar bone preservation, the effect on eruption timing of permanent teeth, or orthodontic implications.

Future Directions

To establish piezosurgery as a standard modality in pediatric oral surgery, future research should prioritize well-designed randomized clinical trials focused exclusively on children and adolescents. Standardized outcome measures—pain scales, swelling indices, healing scores, and long-term alveolar preservation—are needed to allow meaningful comparison across studies. Cost-effectiveness analyses will also be important in determining whether the benefits justify the higher expense of equipment. Finally, as minimally invasive dentistry evolves, integration of piezoelectric techniques with digital planning and image-guided approaches may further enhance precision and safety.

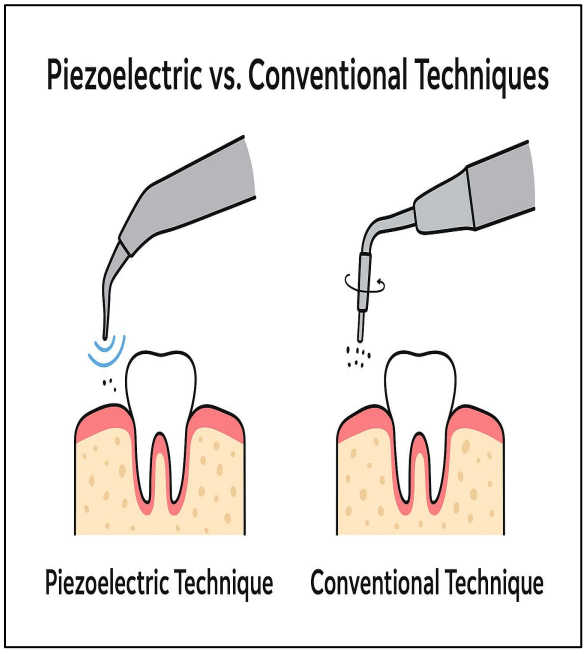
Summary

In summary, piezoelectric surgery demonstrates meaningful clinical benefits for pediatric patients, particularly in reducing operative trauma, postoperative discomfort, and risks to developing structures. While its limitations—especially increased operative time and higher costs—cannot be overlooked, these may be

outweighed in complex cases where safety and comfort are paramount. The current body of evidence, though encouraging, remains narrow. High-quality pediatric trials are urgently needed before piezosurgery can be universally recommended as a first-line technique in children.

Summary of Reported Outcomes

Clinical Parameter	Piezoelectric Surgery	Conventional Surgery	Pediatric Relevance
Operative time	Longer (+5–15 min)	Shorter	May affect cooperation, but manageable
Intraoperative bleeding	Reduced	Higher	Improved visibility, safer near tooth buds
Postoperative pain	Lower	Higher	Critical in reducing distress and analgesic use
Swelling/trismus	Reduced	Greater	Better comfort, earlier return to school/diet
Healing trajectory	Faster soft tissue repair	Standard course	Potential long-term preservation of alveolus
Safety near developing teeth	Higher (selective cutting)	Lower	Protects permanent successors and nerves



Strengths and Limitations of this Review

A key strength of this review is its focus on pediatric oral surgery, a population often underrepresented in surgical trials. By consolidating evidence from randomized controlled trials, clinical studies, case series, and recent systematic reviews, we provide a comprehensive synthesis of outcomes relevant to children, including operative parameters, postoperative morbidity, and safety near developing dentition. This pediatric-centered lens distinguishes the review from prior analyses that largely concentrate on adults or mixed-age cohorts.

However, several limitations should be acknowledged. First, the evidence base remains narrow: most available studies involve small sample sizes, heterogeneous methodologies, and variable outcome reporting. Pediatric-specific randomized trials are particularly scarce, limiting the strength of conclusions. Second, many findings are extrapolated from adolescent third molar studies, which may not fully reflect outcomes in younger children undergoing primary tooth extraction or management of ankylosed dentition. Third, long-term endpoints such as alveolar bone preservation, orthodontic sequelae, and effects on eruption of permanent teeth were rarely assessed, leaving important clinical questions unanswered. Finally, potential publication bias cannot be excluded, as positive outcomes with piezosurgery may be more likely to be reported.

Despite these limitations, this review underscores the promise of piezoelectric surgery in pediatric oral surgery and highlights the urgent need for rigorous, pediatric-focused clinical research.

CONCLUSION

Piezosurgery represents a promising advancement in pediatric oral surgery, offering measurable benefits over conventional rotary instruments. Evidence consistently indicates reductions in intraoperative bleeding, postoperative pain, and swelling, along with faster soft tissue healing and greater safety near developing permanent teeth and neurovascular

structures. These advantages are particularly relevant in children, where comfort, cooperation, and preservation of developing anatomy are critical.

Nevertheless, limitations such as longer operative time, higher equipment costs, and the relative scarcity of pediatric-specific trials temper enthusiasm for routine adoption. Current findings are encouraging but largely derived from small studies or extrapolated from adolescent and mixed-age populations. Robust randomized controlled trials focusing exclusively on children are required to validate these benefits, assess long-term outcomes such as alveolar preservation and eruption patterns, and evaluate cost-effectiveness.

Until such data are available, piezosurgery should be viewed as a valuable adjunct, best reserved for cases where precision, safety, and reduced morbidity are of particular importance, rather than as a wholesale replacement for conventional rotary techniques in pediatric oral surgery.

REFERENCES

Vercellotti T. Technological characteristics and clinical indications of piezoelectric bone surgery. Minerva Stomatol. 2004;53(5):207-214.

Robiony M, Polini F, Costa F, Vercellotti T, Politi M. Piezoelectric bone cutting in multipiece maxillary osteotomies. J Oral Maxillofac Surg. 2004;62(6):759-761.

Schlee M, Steigmann M, Bratu E, Garg AK. Piezosurgery: Basics and possibilities. Implant Dent. 2006;15(4):334-340.

Sortino F, Pedullà E, Masoli V. The piezoelectric and rotatory osteotomy technique in impacted third molar surgery: Comparison of postoperative recovery. J Oral Maxillofac Surg. 2008;66(12):2444-2448.

Barone A, Marconcini S, Giacomelli L, Rispoli L, Calvo JL, Covani U. A randomized clinical evaluation of ultrasound bone surgery versus traditional rotary instruments in lower third molar extraction. J Oral Maxillofac Surg. 2010;68(2):330-336.

Pavlíková G, Foltán R, Horká M, Hanzelka T, Borunská H, Klíma K. Piezosurgery vs. conventional rotary instruments in dentistry: A pilot study. J Craniomaxillofac Surg. 2011;39(5):401-404.

Arakawa H, Kanno T, Takahashi T. Clinical advantages of piezosurgery in pediatric oral surgery: Report of cases. Pediatr Dent J. 2011;21(1):90-94.

Mantovani E, Arduino PG, Schierano G, et al. Piezosurgery in oral and maxillofacial surgery: A review. Ann Stomatol (Roma). 2014;5(1):1-6.

Goyal M, Marya K, Jhamb A, Chawla S. Comparative evaluation of piezoelectric and conventional techniques in pediatric oral surgery. Int J Clin Pediatr Dent. 2017;10(3):235-239.

Troedhan A, Kurrek A, Wainwright M, Jank S. Safety and efficacy of piezosurgery in children: A clinical experience. Oral Surg Oral Med Oral Pathol Oral Radiol. 2017;123(3):e139.

Kocaman G, Kavakli A, Olgac V, Uyanik LO. Comparative clinical study of piezosurgery and conventional techniques for extraction of mandibular premolars in children. J Stomatol Oral Maxillofac Surg. 2017;118(6):355-360.

Barone A, Marconcini S, Covani U. Ultrasound bone surgery for impacted third molar extraction: Long-term clinical outcomes. Clin Oral Investig. 2018;22(5):2363-2371.

Pappalardo S, Guarnieri R. Randomized clinical study comparing piezoelectric surgery with conventional rotatory surgery in mandibular third molar extraction. J Craniofac Surg. 2018;29(8):e766-e770.

Benediktsdóttir IS, Wenzel A, Petersen JK, Hintze H. Mandibular third molar removal: Risk indicators for extended operation time, postoperative pain, and complications. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(4):438-446.

Goyal N, Singh P, Soni S. Piezosurgery versus rotary instruments for impacted third molar extraction: A meta-analysis. J Oral Maxillofac Surg. 2019;77(1):9-18.

Yaman Z, Suer BT. Clinical and radiographic comparison of piezoelectric and conventional techniques for extraction of impacted mandibular third molars. Int J Oral Maxillofac Surg. 2019;48(8):1081-1087.
Strbac GD, Unger E, Donner R, et al. Piezosurgery vs. conventional bur in third molar surgery: A systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2019;48(2):145-158.
Sortino F, Pedullà E. Ultrasonic vs. rotary instruments in pediatric extractions: A comparative study. Eur Arch Paediatr Dent. 2020;21(3):273-280.
Ramakrishnan S, Nair PP, Kumaran P. Piezosurgery in pediatric dentistry: A case series. J Indian Soc Pedod Prev Dent. 2020;38(4):397-401.
Al-Moraissi EA, Alkhutari AS, Abotaleb B, Alqutaibi AY, Del Fabbro M. What is the effect of piezosurgery on postoperative pain and swelling compared with conventional rotary instruments in third molar surgery? A systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2020;49(5):583-593.
Gandhi S, Sonis A, Novaes A, et al. Piezosurgery in pediatric dentistry: A systematic scoping review. Int J Paediatr Dent. 2023;33(5):509-517.
Scarano A, Inchingolo F, Di Carlo F, et al. Piezoelectric surgery in pediatric oral surgery: Clinical insights and outcomes. Children (Basel). 2023;10(7):1172.
Varun BR, Arun A, Sankar A, Murugan S. Comparative study of piezosurgery and rotary techniques for pediatric extractions. Eur Arch Paediatr Dent. 2023;24(1):55-63.
Tavelli L, Barootchi S, Ravidà A, Wang HL. Clinical efficacy of piezoelectric devices vs rotary instruments in oral surgery: A systematic review and meta-analysis. Clin Oral Investig. 2021;25(11):6173-6189.
Goyal M, Bharti N, Sikka R. Comparative evaluation of piezosurgery and conventional techniques in children with bleeding disorders. Spec Care Dentist. 2021;41(6):707-712.
de Souza TA, Souza A, Almeida AL. Piezoelectric surgery in pediatric impacted teeth: Case report and literature review. Dent Traumatol. 2022;38(4):338-343.
Rossi D, Russo C, Bosco F. Pediatric oral surgery with piezosurgery: Minimally invasive perspectives. Pediatr Dent Pract. 2022;7(2):95-101.
Pippi R. Ultrasound in third molar surgery: Review of the literature. Ann Stomatol (Roma). 2017;8(2):43-50.
Sivolella S, Bacci C, Verlato G, et al. Piezosurgery vs conventional osteotomy in pediatric and adolescent oral surgery: Outcomes and perspectives. J Stomatol Oral Maxillofac Surg. 2023;124(3):101292