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PIEZO VS CONVENTIONAL METHOD IN SINUS LIFT: A REVIEW

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ABSTRACT :

Sinus lift surgery is a well-established procedure in implant dentistry for augmenting bone height in the posterior maxilla, particularly when natural bone is insufficient due to resorption, sinus pneumatization, trauma, or congenital defects. Conventional techniques using rotary instruments or osteotomes are widely practiced, providing effective bone augmentation but carrying risks such as Schneiderian membrane perforation, intraoperative bleeding, and postoperative discomfort. Piezoelectric sinus lift, employing ultrasonic micro-vibrations, offers selective bone cutting, superior precision, and enhanced preservation of the sinus membrane, resulting in reduced bleeding, lower complication rates, and improved patient comfort. Clinical outcomes demonstrate comparable implant survival and bone regeneration with both methods, though piezosurgery provides advantages in anatomically challenging cases. Future directions include long-term implant success studies, technological enhancements of piezoelectric devices, and hybrid approaches combining conventional and ultrasonic techniques. Selection of surgical technique should be individualized based on sinus anatomy, residual bone height, and surgeon expertise to optimize safety and outcomes.

Keywords: Sinus Lift, Piezoelectric Surgery, Conventional Technique, Schneiderian Membrane, Implant Dentistry

Introduction

Sinus lift surgery, also known as sinus augmentation, is a widely used procedure in dental implantology aimed at increasing bone height in the posterior maxilla when natural bone is insufficient to support implants. This deficiency may result from alveolar bone resorption following tooth loss, sinus pneumatization, congenital defects, trauma, or disease-related bone loss.[1] The procedure involves elevating the Schneiderian membrane and placing bone graft material beneath it to facilitate new bone formation, thereby providing a stable foundation for implant placement. Anatomical challenges, including the thin and delicate sinus membrane, patient-specific variations in sinus morphology, and proximity to critical structures, demand meticulous surgical technique to prevent complications such as membrane perforation and excessive bleeding.[2] Conventional sinus lift methods typically employ rotary instruments or osteotomes to create a lateral window or perform a transalveolar approach, followed by manual elevation of the membrane and graft placement. While effective, these techniques are associated with risks such as membrane perforation, significant surgical trauma, postoperative swelling, infection, and prolonged healing times before implant placement.[3] In contrast, piezoelectric surgery utilizes ultrasonic micro-vibrations to selectively cut mineralized tissue while preserving soft tissue, thereby reducing the risk of membrane injury and minimizing intraoperative bleeding and trauma. Although the procedure may require longer surgical time, it enhances precision, preserves membrane integrity, and often results in less postoperative discomfort and faster recovery. Both lateral window and internal sinus lift approaches can benefit from piezoelectric technology, making it a valuable tool for managing delicate sinus anatomy.[4] Ultimately, sinus lift surgery remains essential for enabling successful implant placement in patients with inadequate posterior maxillary bone, and the adoption of piezoelectric techniques can improve safety, patient outcomes, and surgical predictability, although the surgeon's skill and careful case selection remain critical determinants of success.[5] This article gives an overview on piezo vs conventional method in sinus lift

Maxillary Sinus Anatomy and Surgical Considerations

The maxillary sinus is a pyramid-shaped, air-filled cavity within the maxilla and represents the largest of the paranasal sinuses, with average dimensions of approximately 36–45 mm in height, 23–25 mm in width, and 38–45 mm in length, containing 12–15 ml of air. Its floor, formed by the alveolar and palatine processes, typically lies about 1 cm below the nasal floor, while the apex extends toward the zygomatic process.[7] The medial wall contributes to the lateral nasal wall, and the sinus features three main processes: alveolar inferiorly, zygomatic laterally, and infraorbital superiorly. The Schneiderian membrane lining the sinus is thin and delicate, with individual variability in thickness, making its preservation during surgical elevation critical to prevent

complications such as perforation, sinusitis, or graft failure. Rich vascularization from branches of the maxillary artery, including the posterior superior alveolar and infraorbital arteries, necessitates careful intraoperative planning to avoid bleeding during lateral window creation or membrane manipulation.[8] Bony septa, present in roughly 27% of cases commonly near first and second molars or second premolars and measuring 2.5–11 mm in height can complicate membrane elevation and increase perforation risk if unrecognized.[9] Understanding anatomical variations such as sinus size, septa location, membrane thickness, ostium patency, and associated pathologies like cysts or mucosal thickening is essential for preoperative planning, often guided by CBCT imaging, to determine incision placement, window size, and surgical technique.[10] Residual bone height dictates technique selection, with lateral window approaches favored for low bone height (<4–6 mm) and less invasive crestal or internal sinus lifts used for moderate bone levels (6–9 mm). Presence of complex anatomy, including large septa, may require modification of the lateral window, staged procedures, or adoption of piezoelectric surgery to enhance precision and minimize membrane damage.[11]

Review of Literature

Comparative studies evaluating piezoelectric and conventional techniques in sinus lift procedures have highlighted notable differences in postoperative outcomes and complication rates, although both approaches are generally effective. Evidence suggests that piezoelectric surgery offers distinct advantages in terms of patient comfort and reduced intra- and postoperative complications. Specifically, piezoelectric methods are associated with lower rates of Schneiderian membrane perforation, reported at approximately 1.7%, compared to 7% with conventional techniques (Hak, 2024).[12] Additionally, patients undergoing piezosurgery tend to experience less postoperative pain and swelling, contributing to faster recovery and improved overall satisfaction (Martins et al., 2021; Delilbasi & Gürler, 2013).[13,14,15] While operative times appear comparable between the two methods, piezoelectric surgery provides enhanced visibility and greater surgical control, factors that may underlie its lower complication rates (Vitkos et al., 2022; Delilbasi & Gürler, 2013).[16] Nonetheless, some studies report that differences in membrane perforation and postoperative discomfort are not always statistically significant, indicating that conventional techniques remain a viable option when performed by experienced surgeons. Overall, the literature suggests that piezoelectric technology offers a safer and more patient-friendly alternative for sinus lift procedures, particularly in cases involving delicate sinus anatomy, while highlighting the continued importance of operator skill and careful case selection.

Conventional Sinus Lift Method

Conventional sinus lift procedures typically utilize rotary burs and hand osteotomes to create access to the maxillary sinus and elevate the Schneiderian membrane. In the lateral window approach, a mucoperiosteal flap is raised to expose the lateral sinus wall, followed by creation of a bony window using rotary burs through a series of vertical and horizontal osteotomies.[17] The window is then removed or displaced to reveal the sinus membrane, which is carefully elevated with curettes or elevators, creating space for bone graft placement, after which the flap is repositioned and sutured. In the indirect, or transalveolar, approach, a crestal incision exposes the alveolar ridge crest, and pilot drilling stops just short of the sinus floor. Progressive tapping with osteotomes elevates the sinus floor and membrane, allowing graft material to be inserted through the osteotomy, with implants placed either simultaneously or at a later stage.[18] Conventional methods are widely accessible and can be performed relatively quickly by experienced surgeons, with the lateral window approach permitting larger graft volumes. However, these techniques carry inherent risks, including higher rates of Schneiderian membrane perforation due to mechanical trauma, reduced tactile feedback with rotary instruments, patient discomfort from osteotome tapping, intraoperative bleeding, and postoperative swelling.[19] Membrane perforations can compromise graft stability and increase infection risk. Despite these limitations, conventional sinus lift methods remain a cornerstone of maxillary augmentation, particularly for cases requiring substantial bone volume, although newer approaches such as piezoelectric surgery provide more controlled, precise, and safer alternatives with reduced complication rates.[19]

Piezoelectric Method in Sinus Lift Surgery

Piezoelectric sinus lift surgery employs specialized ultrasonic devices with micro-vibrating tips that selectively cut mineralized tissue while preserving soft tissues such as the Schneiderian membrane. Tips of varying shapes and sizes are used at different stages, including bone window osteotomy, membrane detachment, and sinus floor elevation. In the lateral window approach, a full-thickness flap exposes the lateral sinus wall, followed by controlled micrometric bone cutting with piezo tips to create the osteotomy. The thin bone plate over the sinus membrane is carefully detached using gentle ultrasonic vibrations, minimizing trauma, and the membrane is elevated with piezo tips or manual elevators.[20] Graft material is then placed beneath the elevated membrane, and the flap is sutured for healing. For crestal or internal sinus lifts, the piezo device allows membrane elevation through the osteotomy site with minimal bone removal. The technique offers significant advantages, including selective bone cutting without soft tissue damage, superior precision and control, reduced intraoperative bleeding due to cavitation and low heat generation, improved visibility, and enhanced patient comfort with less postoperative pain, swelling, and trismus. It can be applied safely in both lateral and crestal sinus lift procedures. Limitations include longer operative times compared to conventional rotary techniques, higher equipment costs, a steeper learning curve for inexperienced surgeons, and limited availability in some clinical settings.[21]

Clinical Outcomes of Sinus Lift Surgery

Clinical evaluations of sinus lift surgery indicate that piezoelectric and conventional techniques each achieve successful bone augmentation and high implant survival, but they differ in intraoperative and postoperative outcomes. Piezoelectric methods generally require longer operative times due to the slower, precise micrometric cutting of bone, whereas conventional rotary or osteotome approaches are faster in experienced hands.[22] Despite this, piezosurgery offers advantages such as reduced intraoperative bleeding, improved visibility, and a significantly lower rate of Schneiderian membrane perforation owing to selective bone cutting and enhanced membrane preservation. Postoperatively, patients undergoing piezoelectric sinus lifts report

less pain, swelling, and ecchymosis, contributing to faster recovery and higher satisfaction, while infection rates remain low for both techniques when proper protocols are followed, with adjunctive measures like platelet-rich fibrin further enhancing healing. Both approaches provide adequate bone regeneration beneath the elevated membrane, supporting successful implant integration, with studies demonstrating comparable bone gain and implant survival rates typically exceeding 95% over one to three years.[23]

Future Directions in Sinus Lift Surgery

Future perspectives in sinus lift surgery focus on enhancing long-term implant success, refining surgical techniques, and integrating technological innovations. Long-term studies, including retrospective analyses of up to 15 years, report high implant survival rates ranging from 95% to 98%, with graft survival exceeding 98% regardless of the type of graft material autogenous, xenograft, or alloplastic. Effective intraoperative management of Schneiderian membrane perforations generally does not compromise graft or implant outcomes, and simultaneous versus staged implant placement protocols show comparable long-term survival when preoperative bone height is appropriately assessed.[24] Technological advancements in piezoelectric devices aim to improve surgical precision, ergonomics, and efficiency. Innovations include handpieces and tips optimized for specific sinus procedures, integration with digital workflows and surgical navigation systems, hybrid ultrasonic instruments combining cutting and irrigation, and hydrodynamic techniques for atraumatic membrane detachment. These developments also target complex anatomical scenarios, such as sinuses with septa or thin membranes, reducing the risk of perforation and intraoperative bleeding. Hybrid approaches combining conventional rotary instruments for initial bone window creation with piezoelectric devices for delicate membrane manipulation are gaining attention, aiming to shorten surgical time while preserving the precision and safety benefits of piezosurgery. Ongoing clinical trials are evaluating hybrid methods versus exclusive technique use in terms of perioperative outcomes, graft integration, and long-term implant success.[25]

Conclusion

Piezoelectric sinus lift offers greater precision, reduced membrane perforation, less intra- and postoperative trauma, and improved patient comfort compared to conventional methods. Evidence supports its use in anatomically complex cases, though conventional techniques remain effective and faster in experienced hands. Technique selection should be individualized based on sinus anatomy, residual bone height, and surgeon expertise.

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