

COMPARATIVE EVALUATION OF CONVENTIONAL ROTARY VS PIEZOELECTRIC INSTRUMENTS IN DIRECT SINUS LIFT PROCEDURE

Dissertation Submitted to

BABU BANARASI DAS UNIVERSITY LUCKNOW, UTTAR PRADESH.



In the partial fulfillment of the requirements for the degree

Of

MASTER OF DENTAL SURGERY

IN

ORAL AND MAXILLOFACIAL SURGERY

By

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BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES

(Faculty of Babu Banarasi Das University)

BATCH: 2022-2025

**DEPARTMENT OF ORAL AND MAXILLOFACIAL
SURGERY**

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ACKNOWLEDGEMENT

With utmost humility and gratitude, I begin by thanking the **Almighty**, whose divine presence has been my guiding light through every stage of this journey. His blessings have provided me with strength, patience, and resilience in the face of challenges.

I express my deepest respect and heartfelt gratitude to my teacher, mentor, and guide, **Prof. Dr Jitender Kr. Aurora**, Professor and Head, Department of Oral & Maxillofacial Surgery, Babu Banarasi Das College of Dental Sciences, Lucknow. His insightful guidance, consistent encouragement, and unwavering support have been pivotal in the successful completion of this dissertation. I consider it a true privilege to have had the opportunity to learn under his supervision. His patience, clarity of thought, and motivation helped me persevere during the most demanding phases of my postgraduate training.

I would also like to extend my heartfelt thanks to **Dr. Ashish Uppal, Dr Amarthya Prakash Srivastava, and Dr.Mohit Saxena** Reader, for their consistent support, valuable suggestions, and willingness to help at every stage. Their kind demeanor and academic input greatly contributed to this work.

I would also like to acknowledge **Dr. Pooja Sehrawat**, Senior Lecturer, for her constant guidance's, valuable suggestions and unstinted help.

I wish to express my gratitude to my seniors, **Dr. Abhijeet Humne, Dr. Maruf Shaikh, and Dr. Pallavi Rai**, who were always approachable, supportive, and generous with their knowledge. Their experience and guidance played an important role in shaping my skills and instilling confidence in me. I value the time, memories, and mentorship I received from them, and I am truly thankful for their presence in my journey.

My heartfelt thanks goes to my batchmates and friends, **Dr. Shivankar Tyagi and Dr. Shiwangi Kumari**, for their companionship, shared academic challenges, and emotional support. The journey of postgraduation was made lighter and more memorable with their presence. Their timely advice, shared responsibilities, and the ability to turn stressful situations into manageable ones were invaluable.

To my beloved juniors — **Dr. Sarvagya, Dr. Vineet, Dr. Aditya, Dr Madhurjya, Dr Nitish and Dr Shipra** — I extend my heartfelt thanks for their cooperation, encouragement, and practical help during my dissertation work. Their assistance and willingness to be involved in various aspects of the project contributed greatly to its smooth execution..

I owe everything to my **Family**. Mere words cannot capture the depth of my love and gratitude for their endless support. To my **Parents** thank you for your boundless love, constant encouragement, and for being the foundation upon which I stand. I express heartfelt thanks for always being there for me, both emotionally and intellectually. I dedicate this work to all of you—for your sacrifices, your faith in me, and your unconditional love.

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I also extend my appreciation to the non-teaching staff—**Nankan Bhaiya, Haider Bhaiya, Simon bhaiya**, and the nursing staff—for their cooperation, assistance, and tireless support throughout this journey. Their behind-the-scenes contributions made a significant impact on the smooth progress of this work.

Finally, I am deeply grateful to my **Patients**, who were an integral part of this study. Their trust, patience, and willingness to cooperate made this research possible. I owe a sincere thanks to each of them for their invaluable contribution.

To all those who directly or indirectly supported me through this journey—if I have unknowingly missed acknowledging anyone, please accept my sincere apologies. Your kindness has not gone unnoticed. Thank you all for being part of this meaningful journey and for enriching my life in countless ways

DR. JAYA MAHATO

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LIST OF ABBREVIATIONS

S.NO.	ABBREVIATED FORM	FULL FORM
1.	%	Percentage
2.	LSFE	Lateral sinus floor elevation
3.	ASA	American Society of Anesthesiologists
4.	LWO	Lateral Window Osteotomy
5.	MLB	Marginal Bone Loss
6.	DBBM	Demineralized Bovine Bone Material

ABSTRACT

Background: Maxillary sinus augmentation has become an indispensable procedure for restoring bone volume in the posterior maxilla where alveolar ridge resorption limits implant placement. Direct sinus lift techniques enable predictable bone augmentation, and the choice of surgical instrumentation plays a pivotal role in minimizing complications such as sinus membrane perforation. Conventional rotary instruments have been widely used; however, piezoelectric surgery has recently gained attention due to its tissue-selective cutting and enhanced surgical precision. This study aimed to comparatively evaluate the clinical performance of piezoelectric devices versus conventional rotary instruments in direct sinus lift procedures, focusing on intraoperative safety, postoperative healing, and primary implant stability.

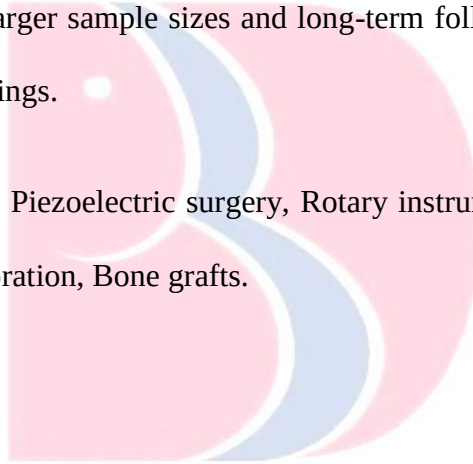
Materials and Methods: A total of 10 patients requiring direct sinus augmentation were enrolled and divided into two groups: Group A (conventional rotary instruments) and Group B (piezoelectric surgery). Sixteen implants were placed across the two groups. Preoperative CBCT imaging was utilized for precise anatomical assessment and surgical planning. Clinical parameters assessed included membrane perforation rate, operative time, postoperative swelling, pain, surgical field visibility, and primary implant stability.

Results: Sinus membrane perforations occurred in 25% of cases using conventional rotary instruments, whereas no perforations were reported with piezoelectric devices. Mean operative time was significantly longer for the piezo surgery group (23.375 minutes) compared to the rotary group (16.625 minutes) ($p=0.001$). Postoperative swelling patterns and pain scores were comparable between groups,

although the piezo surgery group exhibited a trend toward reduced discomfort. All implants achieved satisfactory primary stability, with adequate insertion torque recorded. Bone grafting was performed in three cases where residual bone was inadequate.

Conclusion: Piezoelectric surgery demonstrated superior outcomes in terms of membrane preservation, postoperative comfort, and surgical field visibility, although at the cost of increased operative time. Both techniques, however, achieved favourable implant primary stability and short-term healing. Piezoelectric surgery emerges as a safer and more patient-centred approach for direct sinus lift procedures. Further studies with larger sample sizes and long-term follow-up are warranted to substantiate these findings.

Keywords: Sinus lift, Piezoelectric surgery, Rotary instruments, Dental implants, Sinus membrane perforation, Bone grafts.



INTRODUCTION

Successful implant rehabilitation in the posterior maxilla presents significant clinical challenges, primarily due to compromised bone quantity and quality in this region. The need for predictable, minimally invasive, and effective augmentation techniques has become increasingly important, particularly in cases where alveolar ridge resorption and maxillary sinus pneumatization hinder implant placement. Among the available surgical interventions, the direct sinus lift procedure—also known as lateral window sinus augmentation—remains the gold standard for creating sufficient vertical bone height to support dental implants in severely atrophic maxilla. Tooth loss in the posterior maxilla initiates a cascade of anatomical and physiological alterations that progressively diminish bone volume and density, thereby rendering the site increasingly unfavorable for implant placement. These alteration include progressive alveolar bone resorption and pneumatization of the maxillary sinus, resulting in a reduction of both the height and density of the residual alveolar ridge. Nonetheless, the net effect is a reduction in available bone volume, compromising the primary stability of implants and increasing the risk of implant failure.¹

Residual bone height remains a crucial parameter in determining the optimal surgical approach. When this height is less than 4 mm, a two-stage procedure is typically recommended, wherein sinus augmentation is performed first, followed by implant placement after a healing duration of 6 to 9 months. When residual height lies between 4–6 mm, a simultaneous approach may be feasible, although it requires careful surgical execution to avoid complications.²

In addition to vertical bone quantity, bone quality is a critical factor influencing implant success. The posterior maxilla is often characterized by low-density trabecular bone with thin cortical plates. According to Misch's classification, this region typically presents as either Type III or Type IV bone. Type III bone consists of a thin layer of cortical bone surrounding dense trabecular bone, while Type IV bone is characterized by a thin cortical shell with a core of low-density, porous trabecular bone. Both types are associated with reduced mechanical strength and limited primary stability, making them less favorable for immediate or early loading.³

Among sinus lift techniques, the direct (lateral window) approach is the most widely used in cases of advanced bone atrophy. This technique involves the creation of a bony window on the antero lateral wall of the maxillary sinus, elevation of the Schneiderian membrane, and placement of implant. Although highly effective, this procedure is technique-sensitive and carries inherent risks, the most common of which is perforation of the Schneiderian membrane. The compartment formed by the elevated sinus membrane, implants, and surrounding bone can promote significant bone formation, even in the absence of additional grafts. This underscores the importance of employing careful surgical techniques to maintain the integrity of the sinus membrane during augmentation procedures.²

The choice of instruments utilized in the osteotomy of the antero-lateral wall and elevating the Schneiderian membrane plays a pivotal role in determining the overall success and predictability of the surgical procedure. Traditionally, high-speed rotary burs have been employed due to their affordability, ease of use, and familiarity among clinicians. However, these instruments are associated with several drawbacks. The rotary motion of conventional burs generates substantial mechanical pressure and heat, which may traumatize surrounding tissues and increase the risk of membrane perforation. Moreover, burs provide limited tactile feedback, making precise and conservative manipulation of the sinus wall more difficult. The associated noise and vibration may also contribute to patient discomfort and anxiety during the procedure.³

To address these limitations, piezoelectric surgery has gained prominence as a safer and more precise alternative. This technique incorporates ultrasonic vibrations into surgical procedures which facilitates precise osteotomy of mineralized tissues, while concurrently preserving critical soft tissue structures such as nerves, blood vessels, and the Schneiderian membrane. The selective cutting ability of piezoelectric devices enhances the safety of the procedure by minimizing the likelihood of membrane perforation and reducing intraoperative bleeding. The controlled micromovements of the piezoelectric tip provide superior tactile feedback, enabling the clinician to execute more accurate and conservative osteotomies. Additionally, reduced noise and vibration during the procedure may improve the patient's overall surgical experience and compliance.¹

Several studies have reported favorable outcomes with piezoelectric sinus lift procedures, citing benefits such as reduced incidence of membrane perforation, decreased postoperative swelling, and enhanced patient satisfaction. However, piezoelectric surgery has several limitations: it requires a higher capital investment, involves a steeper learning curve, and may increase surgical duration due to its slower cutting rate compared to conventional burs. Furthermore, clinical evidence comparing piezoelectric surgery with conventional burs in large-scale, controlled studies remains limited. Most available research is based on case series, small cohort studies, or in vitro analyses that lack generalizability and do not comprehensively assess the impact of each technique on clinical and patient-centered outcomes.¹

There is, therefore, a pressing need for systematic investigations that directly compare these two surgical modalities in the context of direct sinus augmentation. A robust clinical comparison encompassing both objective clinical parameters—such as membrane perforation rate, operation time, bone formation—and subjective patient-reported outcomes—such as pain, swelling, and overall satisfaction— can highlight comparative outcomes and applicability of each approach. Such studies are particularly relevant in the current era of patient-centered care, where surgical choices must align not only with biological feasibility but also with patient comfort and procedural acceptability.

This study aims to bridge this gap by conducting a comprehensive clinical evaluation of conventional burs versus piezoelectric devices in direct sinus lift procedures. The primary objective is to compare the two techniques with respect to intraoperative complications, particularly Schneiderian membrane perforation, which remains the most common and impactful risk associated with sinus elevation. Secondary objectives include assessing differences in postoperative pain, edema, operative time, and overall bone formation, thus providing a nuanced understanding of their indications and limitations.

The null hypothesis of this study is that there is no significant difference between conventional bur and piezoelectric techniques in terms of clinical outcomes and patient satisfaction in lateral sinus augmentation. Validating or refuting this hypothesis will provide evidence to guide technique selection and may influence clinical decision-making protocols in implant dentistry.

As the demand for implant-based oral rehabilitation continues to rise globally, particularly among aging populations with high levels of edentulism and compromised bone conditions, the optimization of surgical protocols for sinus augmentation is of paramount importance. Evidence-based recommendations that balance efficacy, safety, cost, and patient experience are essential for guiding clinical practice. Through a structured clinical comparison of two widely utilized osteotomy techniques, this study aims to generate robust evidence that may ultimately offer evidence-based insights to optimize surgical protocols and enhance the predictability of implant outcomes in the posterior maxilla.

AIM

Comparative Evaluation Of Conventional Rotary Instruments Vs Piezoelectric Instruments In Direct Sinus Lift Procedure.

OBJECTIVES

The objective of this study is

- Assessment of operative time and operative site visibility
- Assessment of Schneiderian membrane perforation
- Post-operative pain and swelling
- Primary implant stability

REVIEW OF LITERATURE

1. **Lundgren S et al. in (2004)** ⁴ published a clinical study to evaluate a non-graft-remodeling technique for maxillary sinus floor augmentation. A total of 12 sinus augmentations were performed on 10 patients in average residual bone height of 7mm by creating a bony window and elevating the membrane to create a secluded compartment for the stabilization of the blood clot. Nineteen implants were placed, all protruding ≥ 5 mm into the sinus with no supplementary grafts. Radiograph and CT analysis at 12 month follow up revealed bone formation in the sinus, and RFA indicated that the implant was stable. The authors concluded that this technique is a predictable option to achieve bone regeneration, as it follows guided tissue principles and does not require grafting material.
2. **Barone A et al. (2008)** ⁵ conducted a randomized controlled trial comparing piezosurgery vs. conventional rotary instruments on maxillary sinus floor elevation. Thirteen patients each requiring bilateral maxillary sinus augmentations were included in the study. In each patient osteotomy and elevation of the sinus membrane were performed on one side with the piezoelectric device (test group) and on the other side with rotary instruments (control group). However, the data displayed no substantial difference in clinical parameters such as the osteotomy area, operative time, and bone thickness. Membrane perforation rates were 30% in the study group and 23% in the control group. The study concluded that both methods were comparable, with no significant advantages for either technique in terms of surgical outcomes or complications. The findings suggest that further studies are needed to validate these results on a larger scale.
3. **Sohn DS et al. (2010)** ⁶ conducted a study to assess the formation of new bone in the maxillary sinus using only resorbable gelatin sponge as the graft material. The sinus floor was elevated through the lateral window approach in 7 patients with atrophic maxillae, using piezoelectric devices for the osteotomy and absorbable gelatin sponges were placed round the dental implants. Radiographs at 6 months post-operation showed new bone to be consolidating around the implants, though 2 implants failed due to

inadequate initial stability. The autor concluded that absorbable gelatin sponges were a predictable procedure to induce osteogenesis in sinus augmentation without necessity of various grafts. This strategy may promise a substitute for grafting approaches for sinus augmentation.

4. **Toscano NJ et al. (2010)** ⁷ conducted a retrospective study, 56 lateral window sinus lifts performed on 50 patients with piezoelectric technology along with hand manual instruments. The study was designed to assess complications like Schneiderian membrane perforations and arterial lacerations. No perforations occurred during piezoelectric preparation of lateral windows; in fact, only 2 perforations occurred during subsequent elevation of membranes using hand instruments. The overall perforation rate was 3.6% with 0 arterial laceration. The authors concluded that piezoelectric technology minimised initial complications; thus, by reducing the risk of membrane perforations during sinus elevation procedures, it had demonstrated new role for the procedure itself.
5. **Rickert D et al. (2011)** ⁸ conducted a randomized controlled study between conventional rotative instruments and piezoelectric devices for maxillary sinus floor elevation in 36 patients were performed. The study measured clinical outcomes, such as operation time, bone healing, and complications. The results indicated no significant difference between the two techniques in terms of wound healing, complications (e.g., membrane perforations), and horizontal bone resorption after 3–4 months. Although using piezosurgery was time consuming (15.1 min) against a conventional method (11.1 min), a good implant success ratio achieved in both.
6. **Peñarrocha-Diago M et al. (2012)** ⁹ conducted a comparative study to assess sinus membrane perforation between the rotary technique and ultrasound-based direct maxillary sinus lift. It includes 57 cases of sinus lift in 45 patients (32 with rotary technique, 25 with ultrasound). The results found 7% perforation with the rotary technique versus only 1.7% with ultrasound. Bone gain was 5.9 mm with rotary technique and 6.7 mm with ultrasound. Success rates for implants were 90% using the rotary technique and 98% with ultrasound. The authors concluded that ultrasound offers a lower perforation rate, higher implant survival, and superior bone gain, making it a preferable technique.
7. **Altintas NY et al. in (2013)** ¹⁰ performed a prospective randomized controlled study to evaluate bone formation and density of newly formed bone following maxillary sinus

augmentation with and without bone grafting. A total of 14 patients were included who underwent sinus membrane elevation, with or without additional bone graft material. Bone formation and density were assessed using CBCT scans, at different time points. The data demonstrated new bone formation in both groups, however newly formed bone density was markedly greater in the nongrafted than the grafted group at six months. Sinus membrane elevation without bone grafting produced new bone around the implants, which was denser in the nongrafted group, the authors concluded.

8. **Delibasi C et al in (2013)**¹¹ conducted a comparative study among piezoelectric and conventional rotary instruments in direct sinus lift surgeries. Here, 23 patients who require dental implant therapy in the posterior maxillary region with severe bone deficiency were included. The patients were randomly allocated to both the groups. The author concluded that there was no significant difference between the piezoelectric and conventional groups regarding the incidence of membrane perforation, duration, and operation site visibility, but there was significantly less pain and swelling in the piezoelectric group.
9. **Atieh MA et al. (2015)**¹² conducted a systematic review and meta-analysis comparing piezoelectric devices (PED) and conventional rotary instruments for lateral maxillary sinus floor elevation (LMSFE). The review, which included four studies and 178 procedures, found no significant difference in the rate of sinus membrane perforation (risk ratio = 0.87; P = 0.73) between the two techniques. However, PEDs were associated with significantly longer operating times (mean difference = 3.43 minutes; P < 0.0001). Despite the increased surgical duration, the implant failure rates were comparable. The authors concluded that while both methods are similarly effective in terms of complications and implant survival, the longer operating time with PEDs may influence clinical decisions. Further research is required to assess the long-term implications of these findings, particularly the impact of extended surgical time on patient outcomes and satisfaction.
10. **Lin Y-H et al. (2016)**¹³ conducted a study to evaluate the impact of sinus membrane thickness on perforation rates during lateral window sinus augmentation. 73 subjects of 81 sinus lift procedures are enrolled in the study and cone-beam computed tomography (CBCT) is used to measure membrane thickness pre and post-surgery. The average

membrane thickness was 1.32 ± 0.87 mm and rates of perforation were lowest (7.14%) when membrane thickness ranged between 1–1.5 mm. A statistically significant relationship between thinner/thick membranes and a higher perforation rate was found, suggesting that membrane thickness is an important parameter in terms of the likelihood of perforation occurring during sinus lifts, where an ideal thickness range was suggested at between 1 and 1.5 mm.

11. **Danesh-Sani SA et al. in (2016)**¹⁴, discussed approaches regarding maxillary sinus floor elevation according to the anatomy, surgical features and biomaterials. It reviews two basic approaches lateral window and crestal osteotome techniques, their advantages as well as obstacles. It further reviews different biomaterials including autogenous, allograft, xenograft and alloplasts and discusses their effect on bone regeneration. The authors cite potential complications such as perforation of the membranes and bleeding with an emphasis on the importance of adequate preoperative assessments. Although the lateral window approach is frequently used in the literature, the study recommended additional studies should focus on advanced biomaterials and surgical techniques as they are predicted to lead to more favorable results.
12. **Parra M et al. (2017)**¹⁵ conducted a review assessing the survival rate of dental implants placed using a graftless lateral window sinus lift procedure. They scrutinized eleven studies of which nine were prospective and the remaining two retrospective. The outcome revealed an impressively high implant survival percentage of ninety-seven along with an average maxillary bone augmentation of 6.2mm. While these figures signaled promising results, the authors emphasized the research designs suffered from weak methodological quality with scant reporting of patient inclusion standards and mechanisms influencing implant success. The review concluded that though graftless sinus lifts demonstrate sizable implant and bone gains, more rigorous investigations are still required to define clear applications, optimize surgical methods, and fully comprehend the biological pathways enabling positive outcomes.
13. **Jordi C et al. (2018)**¹⁶ performed a meta-analysis comparing membrane perforation rates during lateral maxillary sinus floor elevation using conventional rotary instruments and piezoelectric devices. The study included 69 articles and found that conventional instruments had a 24% perforation rate, while piezoelectric devices had a significantly lower perforation rate of 8%. The authors concluded that piezoelectric devices

significantly reduce membrane perforation risks during sinus lifts and recommend their use for enhanced surgical outcomes.

14. **Otake Y et al. (2018)** ¹⁷ conducted an experimental study conducted on 6 rats comparing piezosurgery and conventional rotary instruments in terms of cutting performance on bone and soft tissue. The results showed that piezosurgery took longer to cut bone, but it provided a smoother bone surface and caused minimal damage to adjacent soft tissues, such as the tongue. The study concluded that piezosurgery, although requiring more time, offers better precision and safety by preserving soft tissues during bone surgeries.
15. **Shahakbari R et al. (2020)** ¹⁸ performed a double-blinded randomized clinical trial to compare the efficacy of piezosurgery and conventional surgical bur in the reduction of postoperative pain and edema after open sinus lift surgery. Twenty patients were included in the study and were operated with sinus lift surgery bilaterally in the maxilla either with piezosurgery or a surgical diamond bur. The results indicated no differences in postoperative pain or edema between groups on days 2 and 7 post-surgery. In contrast, the piezosurgery group had a significantly longer mean surgical duration. They found that the clinical outcomes of piezo-surgery were comparable to that of the conventional bur; however, the precise cutting ability and reduced soft tissue damage created by using piezosurgery might make it a considerable alternative to the conventional bur although the procedure might take longer with piezosurgery.
16. **Martins M et al. (2021)** ¹⁹ conducted a pilot randomized trial to compare the postoperative effects of piezosurgery and conventional rotary instruments in Schneiderian membrane sinus lifting. A total of 20 patients requiring bilateral maxillary bone graft augmentation were selected. Piezosurgery was performed on one side, and conventional rotary instruments were used on the other. Pain, edema, and mouth opening were evaluated at one hour, two days, and seven days post-surgery. The results showed significantly lower pain ($p < 0.05$) and greater mouth opening ($p = 0.0180$) at 48 hours in the piezosurgery group. Edema did not differ significantly between the two techniques. By day 7th, pain levels and mouth opening were similar for both groups. The authors concluded that piezosurgery resulted in less pain and better postoperative mouth opening, making it a favorable option for sinus lifting procedures.
17. **Shenoy SB et al. (2021)** ²⁰ reviewed complications associated with sinus augmentation procedures, emphasizing membrane perforation (60%), infection (21%), and bleeding

(9%) as the most common. Membrane perforation survival rates were 97.14% for tears <5 mm, 91.89% for 5-10 mm, and 74.14% for >10 mm. The study stressed the importance of preoperative evaluations, including CBCT scans, to assess sinus anatomy and detect pre-existing conditions. Small perforations can be managed by suturing or resorbable membranes, while larger tears require staged approaches or coverage with lamellar bone, fat pads, or bone block grafts. The authors concluded that careful planning, assessment, and early complication management are essential for improving success rates in sinus augmentation procedures

18. **Schiavon L et al. (2022)** ²¹ conducted a systematic review and meta-analysis to assess the repositioned bone lid technique in lateral sinus lift procedures. Five animal studies and two clinical trials were included. The animal studies, using rabbit and sheep models, demonstrated that repositioning the bone lid resulted in significantly higher bone regeneration compared to controls, with new bone formation observed at 2, 4, and 8 weeks. In clinical trials, no significant differences were found between repositioned bone lids and resorbable membranes in terms of bone regeneration. The bone lid technique showed good short-term implant survival rates, with no major complications reported. The meta-analysis concluded that the repositioned bone lid technique enhances new bone formation, offering an alternative to resorbable membranes in sinus augmentation procedure.
19. **Asmarani SL et al. (2022)** ²² conducted a scoping review to evaluate bone height and width on panoramic radiographs before dental implant placement. The study analyzed five retrospective studies published between 2010-2021. The results showed that bone height ranged from 7.95 mm to 23.42 mm, while bone width ranged from 7.04 mm to 10.41 mm across various jaw locations. Specific data included anterior maxilla bone height of 11.47 mm and posterior maxilla bone width of 5.37 mm. The review concluded that panoramic radiographs are a valuable tool for evaluating bone availability before implants, particularly in the posterior mandible. These radiographs aid in ensuring optimal implant placement, considering anatomical structures like the mandibular canal and maxillary sinus. The study emphasized that accurate bone measurement is critical for successful implant integration.
20. **Mordini L et al. (2022)** ²³ published a systematic review and meta-analysis to assess the use of corticosteroids in lateral maxillary sinus augmentation (MSA). A total of 37

studies with 1599 patients were included, comparing corticosteroid (Cort) and non-corticosteroid (No-Cort) groups. The analysis revealed that corticosteroids significantly reduced postoperative swelling (Cort: 9.3%, No-Cort: 10.8%) and pain (Cort: 6.2%, No-Cort: 4.9%) but had no substantial effect on wound dehiscence, trismus, or hematoma. The complication rates, including infection, were similar between both groups, with active suppuration slightly lower in the Cort group (1.7% vs. 3.2%). The study concluded that although corticosteroids may offer benefits in reducing some postoperative symptoms, the overall complication rates did not differ significantly, and more research is needed to confirm their effectiveness in MSA procedures.

21. **Nandagopal N et al. (2022)** ²⁴ published an review on the use of piezosurgery in maxillofacial practice. Piezosurgery, based on the piezoelectric effect, enables precise cutting of bone while sparing adjacent soft tissues. It has shown benefits such as improved wound healing, reduced blood loss, and less patient discomfort. The technique is gaining popularity in procedures like sinus lifts, impacted third molar removal, bone harvesting, and dental implantology. Studies report reduced complications like membrane perforation in sinus lifts (5% perforation rate) and lower postoperative pain and swelling in third molar surgeries. Despite being time-consuming, piezosurgery offers better safety and precision, particularly near vital structures.
22. **Singh R et al. (2022)** ²⁵ compared lateral sinus augmentation utilizing a Lateral Approach Sinus Kit to rotary techniques in 14 patients in 2022. The LAS Kit® achieved a significantly decreased operative time (19.43 ± 2.88 minutes vs. 28.29 ± 2.21 minutes) and a significantly lower sinus membrane perforation rate (0% vs. 28.6%). Both methods led to 100% implant integrity after 6 month. In conclusion, the LAS Kit® was safer and more efficient than other approaches considered, particularly with Type I and II sinus membranes, suggesting decreased risk of complications and reduced time spent on this procedure.
23. **Molnár B et al. (2022)** ²⁶ conducted a comparative study on lateral maxillary sinus augmentation using piezosurgery with bony wall repositioning versus rotary instruments with collagen membrane coverage. Forty patients were included, with 20 in each group. After 6 months, histological analysis revealed no significant differences in bone substitute material, connective tissue, or newly formed bone between the groups. However, piezosurgery with bony wall repositioning showed similar results to collagen

membrane coverage, indicating its effectiveness as a reliable method for sinus augmentation.

24. **Valentini P et al. (2023)** ²⁷ reviewed the lateral window osteotomy (LWO) technique in sinus augmentation. The study emphasized minimizing invasiveness, reducing complications, and enhancing outcomes through understanding anatomical variations like sinus membrane thickness and bone quality. The authors compared LWO with transcrestal techniques and highlighted the advantages of LWO in achieving superior bone gain, though noting that the procedure requires careful surgical planning. Additionally, they found that the application of piezoelectric surgery tools in LWO significantly reduced complications such as membrane perforations.
25. **Gao et al. in (2023)** ²⁸ conducted a retrospective study to evaluate a minimally invasive technique for lateral maxillary sinus floor elevation (LSFE) using a small lateral bone window. A total of 30 patients with an average residual bone height of 3.39 mm underwent the procedure, with a bone window size of 4.4 mm in height and 6.26 mm in length. Over a 3.67-year follow-up, no implants failed, and the average bone height gain was 8.07 mm. The study found that nonsmokers and the use of deproteinized bovine bone mineral (DBBM) graft material significantly minimized bone height loss. The technique showed a high implant survival rate and limited graft resorption, making
26. **Gad EL-Hak et al. (2023)** ²⁹ compared piezoelectric ultrasound surgery with conventional rotary techniques in maxillary sinus floor elevation with simultaneous implant placement. The incidence of sinus membrane perforation was 7% in tests performed with piezosurgery, which is lower than the 10-35% perforation of rotary methods. Secondly, the piezoelectric method was also able to increase implant survival and bone acquisition, with a success rate of 100% in the integration of the implants. Pain and swelling postoperatively were also significantly decreased with less discomfort than those treated with rotary instruments. It was concluded in the study piezoelectric ultrasound surgery, although a time-consuming method, gives more accuracy, minimizes complications and improves clinical outcomes, so it is a method of choice for sinus elevation procedures.
27. **Alshamrani et al. (2023)** ³⁰ conducted a comprehensive review of maxillary sinus lift procedures, highlighting various surgical techniques and complications. The study focused on two main techniques: the osteotome technique, preferred for bone heights >5

mm, and the lateral window technique, used when bone height is less than 5 mm, which can increase bone height by up to 9 mm. The review noted that sinus membrane perforation occurs in 20%-44% of cases using the lateral window approach. It also emphasized the importance of presurgical evaluations with CBCT scans to assess membrane thickness and the presence of septa. The study concluded that meticulous evaluation and technique selection significantly reduce the risk of complications and improve implant outcome.

28. **Testori et al. (2023)** ³¹ conducted a review on maxillary sinus elevation surgery complications. The most frequent intraoperative complication is perforation of the membrane, occurring in 20%-44% of cases. They pointed out that smaller perforations (10mm) decrease implant survival to 74%. The study concluded that preoperative evaluations such as 3D radiographs and familiarity with sinus anatomy before implants placement is indispensable to reduce complications. They found that complications, including bleeding and perforation, could be well managed, with collagen membranes and platelet-rich fibrin which promotes healing.
29. **Abdulmageed et al. (2024)** ³² compared piezosurgery and rotary techniques for direct maxillary sinus lifting in 15 patients. The results showed that piezosurgery significantly reduced postoperative swelling and pain compared to rotary tools. After 2 days, the piezo group experienced less swelling, with significant differences observed in measurements around the face. Pain levels were also lower in the piezo group, particularly within the first 6 hours and 2 days post-surgery. Although rotary tools allowed for faster bony window opening, piezosurgery offered a more comfortable recovery with less swelling, pain, and better mouth opening. The study concluded that piezosurgery is a preferred choice for improving postoperative patient comfort.
30. **Valentini et al. (2024)** ³³ reviewed intraoperative complications in maxillary sinus augmentation, and particularly sinus membrane perforations. Perforation rates with lateral approaches ranged from 15.7% to 23.1% vs lower values with transcrestal approaches (3.1% to 6.4%). However, with the employment of endoscopy in transcrestal approaches, perforation rates increased up to 40%. This study stressed the risk of perforation, which is more prevalent in the narrow sinuses; its incidence is over 60% when the sinus width is below 30°. Author also noted that smoking did carry a higher risk of perforation, with a perforation rate of 41.2% among smokers. The authors

concluded that careful preoperative planning and careful technique selection are important factors minimizing complications

31. **Jadach et al. (2024)** ³⁴ conducted a study to classify maxillary sinuses for sinus lift procedures in Polish patients. They analyzed 200 CBCT scans, focusing on the thickness of lateral and palatal walls of the maxillary sinus. Four classes were identified: Class 0 (4%) indicated sufficient bone height with no need for sinus lift; Class 1 (44%) had a thinner lateral wall, suitable for lateral or crestal window techniques; Class 2 (49%) showed comparable thickness in both walls, allowing any window technique; and Class 3 (3%) had a thinner palatal wall, indicating a palatal approach. The study concluded that this classification aids in choosing the optimal sinus lift technique based on anatomical variations.
32. **Nageh et al. (2024)** ³⁵ conducted a comparative study to evaluate piezoelectric ultrasound surgery versus conventional rotary techniques in maxillary sinus lifting with simultaneous implant insertion. A total of 24 patients, with residual bone height of 5-7 mm, underwent sinus lift using either piezosurgery (Group I) or conventional rotary techniques (Group II). The study observed that the incidence of sinus membrane perforation was significantly lower in the piezosurgery group (1.7%) compared to the rotary group (7%). Additionally, implant stability and bone density were significantly higher in the piezosurgery group over 6 and 9 months. The study concluded that piezosurgery offers a more precise and safer approach, making it the preferred option for sinus lift procedures with implant placement.
33. **Sağlanmak et al. (2025)** ³⁶ conducted a retrospective analysis on 289 implants placed using the lateral window technique for maxillary sinus augmentation in 101 patients. Over a mean follow-up of 12.4 years, the study reported a cumulative implant survival rate of 92.93%. Marginal bone loss (MBL) after 15 years averaged 1.80 mm, showing no significant differences between implants placed in perforated and intact sinuses. Small sinus membrane perforations (≤ 4 mm) did not significantly affect implant survival when treated with collagen membrane repair. The study concluded that the lateral window technique is a reliable, long-term effective method for sinus augmentation and implant placement. Additionally, it highlighted that small membrane perforations do not compromise long-term implant success, further validating the robustness of the technique.

SAMPLE SIZE DETERMINATION

The sample size was calculated using G Power software (version 3.1.9.6). Based on the 95 percent power of the study and 5 percent type I error and effect size of 1.80 the sample size came out to be 16 i.e 8 in each group

STATISTICAL ANALYSIS

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation frequency and percentage. The level of the significance for the present study was fixed at 5%.

The intergroup comparison will be done using the independent t tests/Mann Whitney U test and intragroup comparison will be done using the Repeated Measures ANOVA/Friedmann Test The Shapiro–Wilk test was used to investigate the distribution of the data and Levene’s test to explore the homogeneity of the variables.

STUDY /RESEARCH DESIGN

The present study was conducted in the Department of Oral and Maxillofacial Surgery, Babu Banarasi Das College of Dental Sciences, Lucknow with an aim to compare and evaluate the efficacy of conventional rotary instruments and Piezoelectric approaches in direct sinus Lift procedure after taking approval from the '**Institutional Human Ethical Committee**' and '**Institutional research development committee**' (*ANNEXURES I & II*).

The present study having a sample size of 16 patients, irrespective of their gender, caste, creed, socioeconomic status, and religion, as per inclusion criteria.¹¹

The study population was divided into two groups by Closed envelop shield method

Group 1- included patients who underwent the sinus lift procedure using conventional rotary burs,

Group 2- comprised patients who underwent the sinus lift procedure with piezosurgical instruments.

SAMPLE SELECTION

INCLUSION CRITERIA

- ASA I & II [except lactating mother & pregnant women]
- Optimal oral hygiene
- Unilateral or bilateral edentulous atrophic maxilla
- Healthy maxillary sinuses
- 4-6 mm of residual bone height as per CBCT

EXCLUSION CRITERIA

- Patient not younger than 18 yrs of age
- Uncontrolled systemic diseases
- Patient on bisphosphonate therapy
- History of previous unsuccessful sinus augmentation.

MATERIALS

Materials and Equipment Used in the study:

- Minor oral Surgery armamentarium
- Piezoelectric Unit with piezotips (satellac-acetone)
- Sinus curettes
- No.701 tapered fissure bur
- Mallet
- Physiodispenser
- Bone Graft-Geistlich Bio-Oss pen/granules
- Resorbable GTR membrane (Geistlich bio-oss GTR Membrane)
- 3-0 Silk suture/Vicryl suture (ethicon suture)



Fig 1: Instruments

Fig 2 :Piezosurgical unit (Acetone)



Fig- 3: Sinus curettes

Fig-4: Physiodispenser for simultaneous placement of dental implant.

METHODOLOGY

All surgical procedures were carried out by a single surgeon using the same protocol in the posterior maxillary region. A comprehensive medical history and standard laboratory investigation were performed for all patients preoperatively. Preoperative antibiotic coverage with nasal decongestant was administered 12hr prior to surgery and was continued till 5th day postoperatively

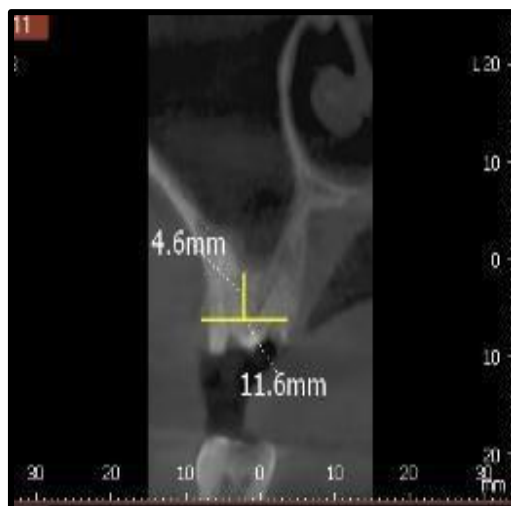
Direct Sinus lift procedure: The procedure was performed under strict aseptic conditions. Local anesthesia was achieved by administration of infraorbital, PSA and greater palatine nerve block with 2% lidocaine and 1:200,000 epinephrine. A crestal incision was made using a 15 No. BP blade, with vertical releasing incisions at the mesial and distal aspects of the buccal site. A full-thickness trapezoidal mucoperiosteal flap was then elevated, ensuring that the attached gingiva on the adjacent teeth remained undisturbed. The flap was raised superiorly to expose the anterolateral wall of the maxillary sinus. These steps were consistent across both groups.

IN GROUP 1

- A bony window of 15-30 mm was made using round bur under copious saline using medium speed straight Surgical Hand piece and no. 701 bur. Inferior cuts were placed 0.5 to 1cm above the floor of the sinus and vertical cuts were made according to the edentulous arch and the number of implants to be placed. All the edges of the bony window which could cause perforation of the schneiderian membrane during elevation were rounded off. The sinus membrane was gently elevated from the bony floor by means of sinus curette. It was important to free the sinus membrane in all direction before attempting to intrude the trapdoor inwardly. A space was created after the sinus membrane has been elevated by the intruded trapdoor. Meticulous elevation of the Schneiderian membrane was performed²⁵

GROUP 1 CASE 1

PRE-OPERATIVE



INTRA-OPERTIVE



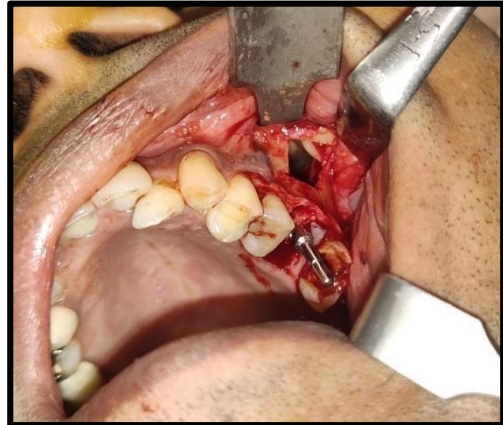
Reflection of the flap



Osteotomy Of the Bony Window



**Elevation Of the Sinus Membrane
With Sinus Curette**



**Sinus the Membrane Elevation
With Osteotomy Of Implant**



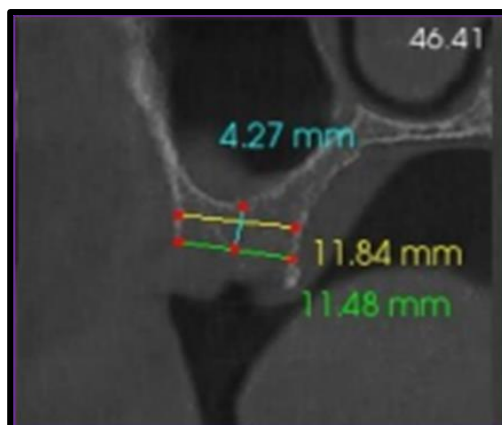
Closure Of The Surgical Site

POST-OPERATIVE



GROUP I CASE-II

PRE-OPERATIVE



INTRA-OPERATIVE



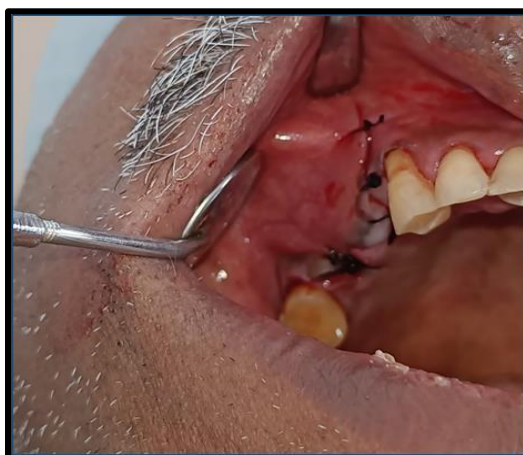
Reflection Of The Flap



Osteotomy Of The Bony Window



Elevation Of The Sinus Membrane



Closure Of The Surgical Site

POST-OPERATIVE



GROUP II

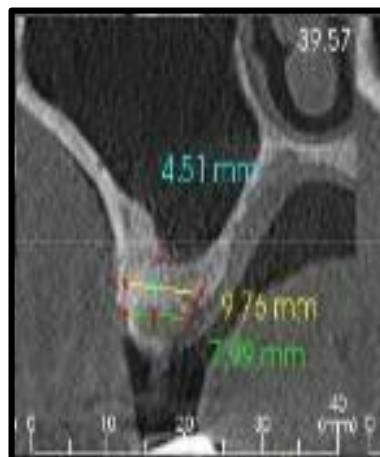
- A bony window 15-30 mm was marked 0.5 to 1cm above the sinus floor using marking pencil. An ultrasonic piezoelectric device (acetone, piezotome) to which specialized tips is attached , was used to perform the osteomy under copious saline irrigation , a frequency of 25 to 29khz with a microvibration of 60 to 200mm/sec was used. The schniderian membrane was dissected from all direction and gently elevated using sinus curettes. Bony window was left attached to the sinus membrane and served as new sinus floor.

Sinus membrane integrity was tested by asking the patient to breath in deeply/ Valsalva maneuver while observing the membrane movement in both the groups.

In single stage cases implants were placed at the same time by using drills in sequential manner and extended into the space achieving primary stability from the residual alveolar bone. The space between implant and schneiderian membrane was filled with blood coagulum or bone graft depending upon the cases. The lateral window was covered by collagen membrane of size 10* 10 mm. Then, mucoperiosteal was closed with 3-0 round body vicryl suture.¹⁸

GROUP II CASE I

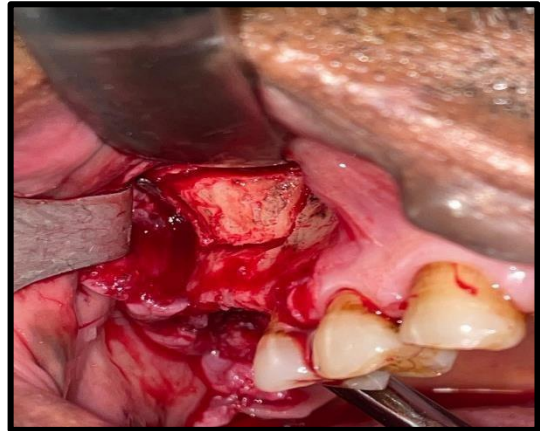
PRE-OPERATIVE



INTRA- OPERATIVE



**Reflection Of The Flap &
Marking Of The Bony Window**



Osteotomy Of The Bony Window



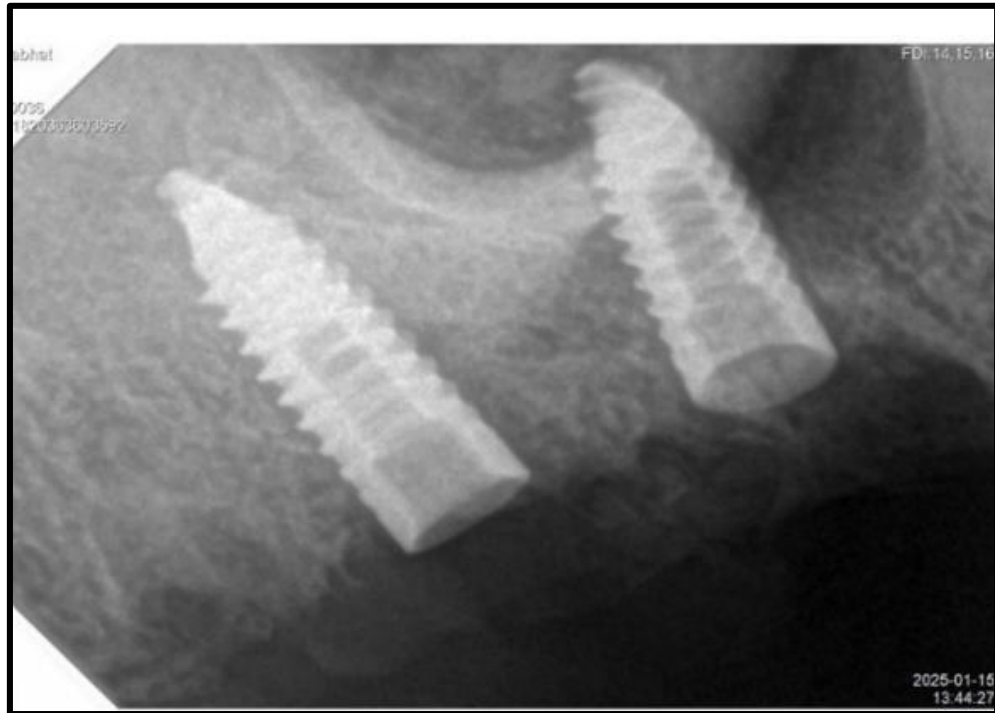
Elevation of the sinus membrane



Placement Of the Collagen Membrane

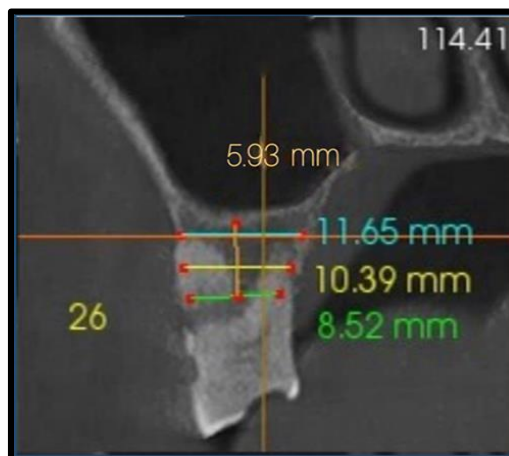


Closure Of The Surgical Site

POST-OPERATIVE

GROUP II CASE-II

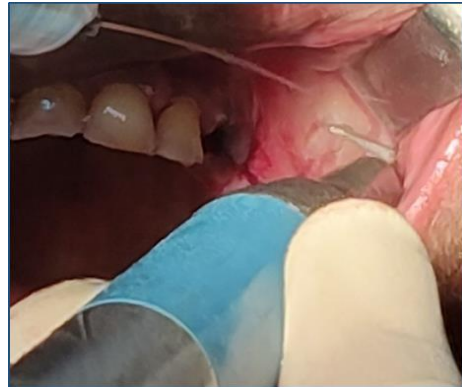
PRE-OPERATIVE



INTRA- OPERATIVE



Reflection of the flap



**Osteotomy Of The Bony Window
With Piezoelectric Unit**



Osteotomy On The Anterolateral Wall



Placement Of The Graft



Closure Of The Surgical Site

POST-OPERATIVE

Patient was advised to follow standard postoperative instruction which includes ²⁵ :

- a) Application of ice pack and soft high nutrient dietary intake.
- b) Patients were advised to abstain from spitting or rinsing the mouth forcefully for 24 hours following the procedure.
- c) Patient were advised not to put any external pressure with tongue, avoid forceful sneezing.
- d) Intake of prescribed medication for 5 days.
- e) Nasal decongestant (xylometazoline 1%) and anti-allergic medication (levocetirizine 5 mg) were promptly prescribed and administered following the procedure.
- f) Patients were advised to begin warm saline mouth rinses and steam inhalation 24 to 48 hours after surgery, continuing for a duration of one week, mouth wash chlorhexidine was prescribed 24 hr after surgery.

EVALUATION OF CLINICAL PARAMETERS

Patient evaluation was done using the following Parameters. (*ANNEXURES VII*)

1. **SINUS MEMBRANE PERFORATION**: the integrity of sinus membrane was assessed by Valsalva maneuverer ¹⁸
2. **OPERATION SITE VISIBILITY**- visibility site was assessed with a 4 point scale.¹¹
 - 0-very poor visibility
 - 1-modern visibility
 - 2- good visibility
 - 3-excellent visibility
3. **OPERATION TIME** –Operative time was calculated from the incision to completion of osteotomy. ¹¹
4. **SWELLING** -A 3-line measurement of the face was done pre-operatively and postoperatively on 2nd day and 7th day for the measurement of swelling ³⁷:
 - a) Mandibular angle to external eye corner
 - b) Mandibular angle to internal eye corner
 - c) Mental protuberance to external eye corner.



5. **PAIN** - Pain was evaluated on the Wong bakers pain scale and the patient were instructed to tick on the appropriate reading based on their perception of pain both pre- and post-operatively. Post-operative evaluation of pain was done after the 1st hour, 2nd day, and 7th post-operative days.³⁸



RESULT AND OBSERVATIONS

The present study was conducted in the Department of Oral and maxillofacial surgery, Babu Banarasi Das College Of Dental Sciences , with an aim to compare and evaluate the conventional rotary instruments versus Piezosurgery in direct sinus lift procedure in the posterior maxilla. A total of 16 patients were equally assigned randomly into two groups (conventional and piezoelectric) based on the inclusion and exclusion criterias for sinus augmentation using close envelope method of randomization. Group – I composed of patients undergoing sinus lift with conventional rotary burs it includes 1 female patient and 7 male patient. Group II composed of patients undergoing sinus lift with piezosurgical tips which includes 4 female and 4 male patient . All surgical procedures were carried out by a single surgeon using the same protocol in the posterior maxillary region. Assessment of schneiderian membrane perforation, operation time, operation site visibility, postoperative pain and swelling was evaluated based on the evaluation criteria. The results are tabulated as follows :

TABLE 1 - GENDER DISTRIBUTION AMONG STUDY SUBJECTS

	Female	Male
Group I	1	7
	12.5%	87.5%
Group II	4	4
	50.0%	50.0%

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit

The gender distribution among the study subjects was analyzed for two groups, Group A and Group B, which were assigned different treatment modalities. In **Group I**, which used the conventional rotary instrument, there was a notable gender imbalance, with only 1 female participant (12.5%) compared to 7 male participants (87.5%). On the other hand, **Group II**, which utilized the piezo surgery device and piezo elevator, exhibited an equal gender distribution, with 4 female participants (50%) and 4 male participants (50%).

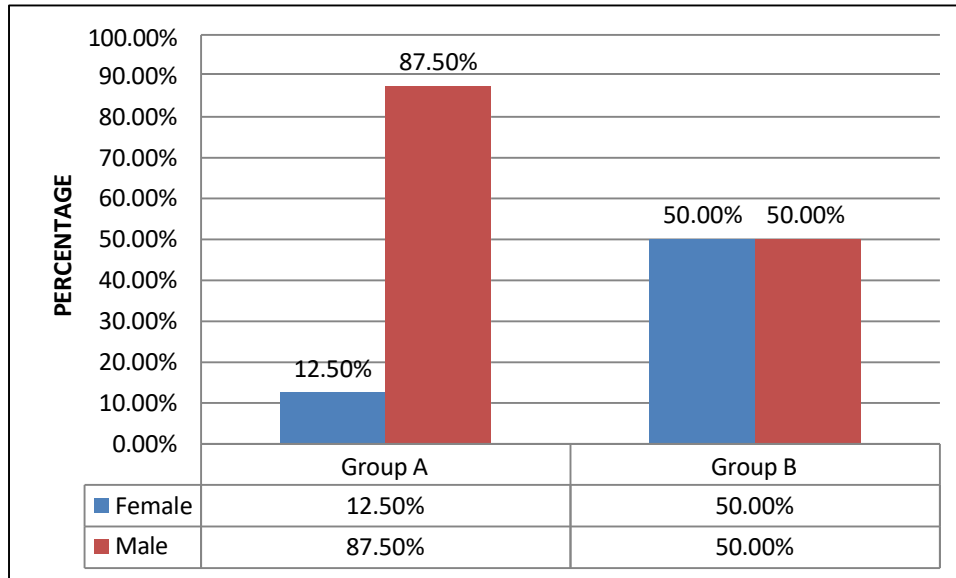


TABLE 2 - MEAN AGE AMONG STUDY SUBJECTS

	Mean	Std Dev	Std Error
Group A	47.125	16.711	5.908
Group B	53.000	13.373	4.728

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit

The mean age of participants differed between the two study groups. In **Group I**, which used the conventional rotary instrument, the average age was **47.125 years**, with a standard deviation of **16.711 years**, indicating a relatively wide age range among participants. The standard error was **5.908 years**, reflecting the variability in the age estimate. In contrast, **Group II**, which utilized the piezo surgery device, had a higher mean age of **53.000 years**, but with less variation in age, as evidenced by a standard deviation of **13.373 years**.

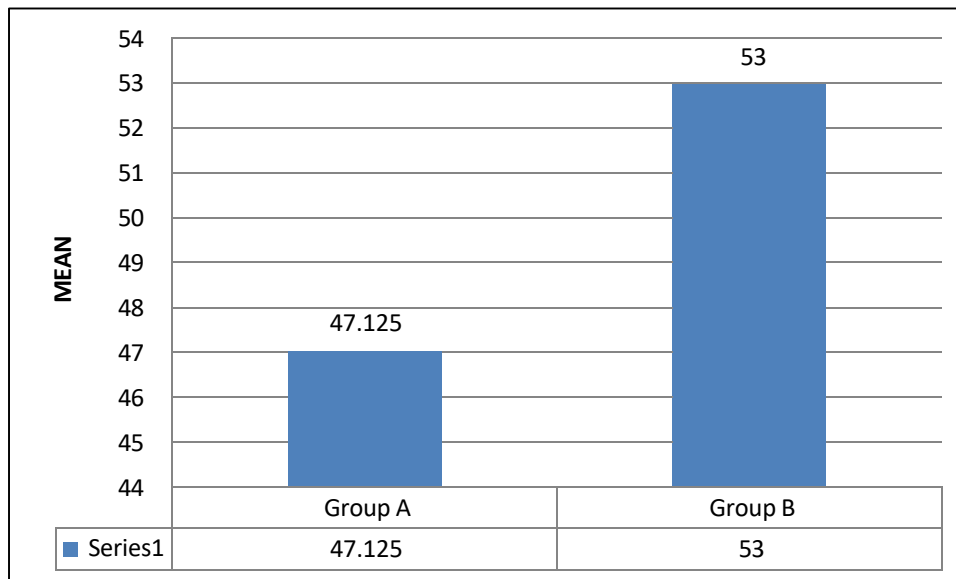


TABLE 3 - SINUS PERFORATION AMONG STUDY SUBJECTS

	No	Yes	P value	Significance
Group A	6	2	0.233	Non-Significant
	75.0%	25.0%		
Group B	8	0		
	100.0%	.0%		

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit.

The incidence of sinus perforation was analyzed across the two groups. In **Group A** (Conventional Rotary Instrument), **2 participants** (25%) experienced sinus perforation, while **6 participants** (75%) did not. In **Group B** (Piezo Surgery Device and Piezo Elevator), no participants experienced sinus perforation, with all **8 participants** (100%) showing no complications. The **p-value** for this comparison was **0.233**, which is greater than the commonly used threshold of 0.05, indicating that the difference between the groups in terms of sinus perforation is **not statistically significant**.

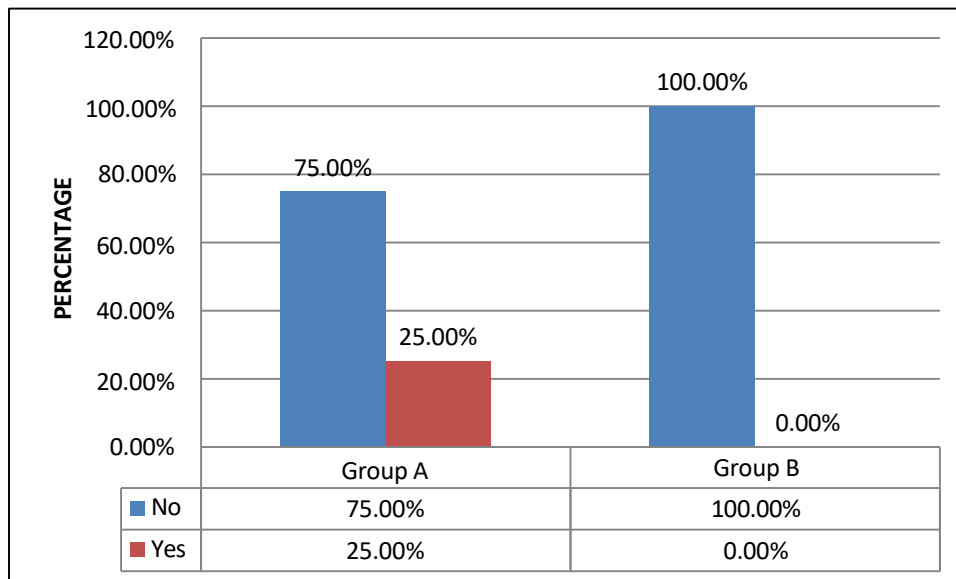


TABLE 4 - OPERATOR SITE VISIBILITY SCORE AMONG STUDY SUBJECTS

	Mean	Std Dev	Std Error	P value	Significance
Group A	2.625	0.518	0.183	0.819	Non-Sig
Group B	2.750	0.463	0.164		

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit.

The **operator site visibility score** was assessed to evaluate the ease of visibility during the procedures. **Group A**, which used the conventional rotary instrument, had a mean score of **2.625**, with a standard deviation of **0.518** and a standard error of **0.183**. In comparison, **Group B**, which used the piezo surgery device and piezo elevator, had a slightly higher mean score of **2.750**, with a standard deviation of **0.463** and a standard error of **0.164**. The **p-value** for the comparison between the two groups was **0.819**, which is much higher than the typical threshold of **0.05**, indicating that the difference in visibility scores between the two groups is **not statistically significant**. This suggests that the operator's site visibility was similar between the two groups,

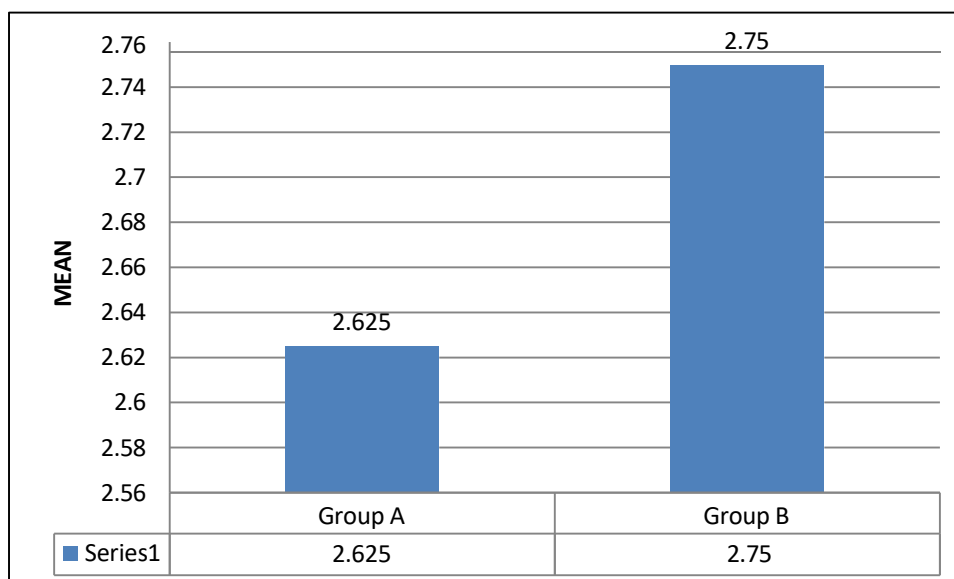


TABLE 5 - OPERATION TIME AMONG STUDY SUBJECTS

	Mean	Std Dev	Std Error	P value	Significance
Group A	16.625	1.685	0.596	0.001	Significant
Group B	23.375	2.615	0.925		

Group A –Conventional Rotary Instrument, Group B – Piekosurgical unit

The **operation time** was compared between the two groups, with **Group A** (Conventional Rotary Instrument) having a mean operation time of **16.625 minutes**, accompanied by a standard deviation of **1.685 minutes** and a standard error of **0.596 minutes**. **Group B** (Piezo Surgery Device and Piezo Elevator) had a longer mean operation time of **23.375 minutes**, with a standard deviation of **2.615 minutes** and a standard error of **0.925 minutes**. The **p-value** for this comparison was **0.001**, which is well below the significance threshold of **0.05**, indicating a **statistically significant** difference between the two groups in terms of operation time.

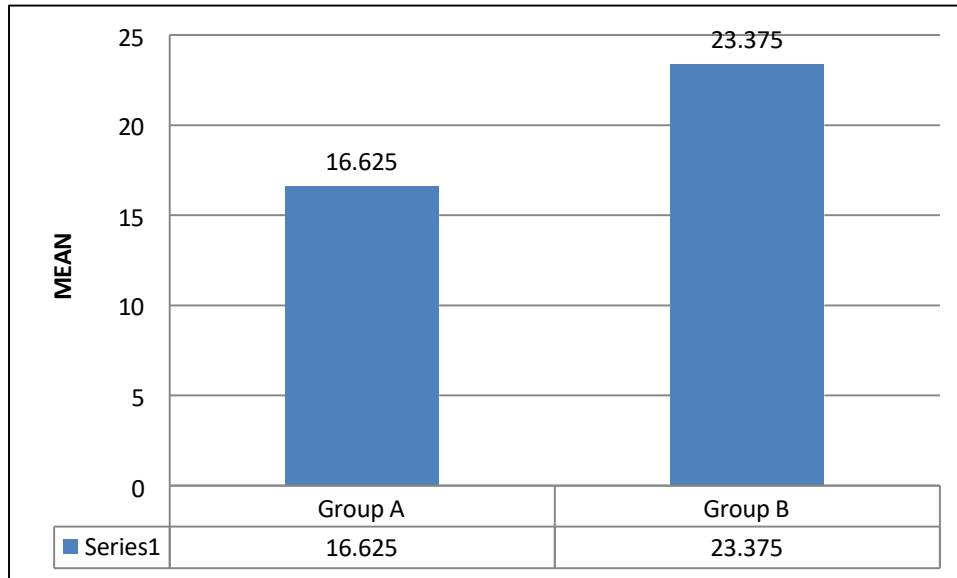


TABLE 6 - INTERGROUP COMPARISON OF SWELLING AT EXTERNAL EYE CORNER TO ANGLE OF MANDIBLE BETWEEN THE GROUPS

		Mean	Std Dev	Std Error	P value	Significance
Pre Op	Group A	11.375	1.103	0.390	0.950	Non-Significant
	Group B	11.350	0.805	0.285		
2 nd Day	Group A	11.850	1.177	0.416	0.750	Significant
	Group B	11.688	0.774	0.273		
7 th Day	Group A	11.475	1.103	0.390	0.820	Significant
	Group B	11.363	0.812	0.287		

Group A –Conventional Rotary Instrument, Group B - Piezo Surgical Unit

The comparison of **swelling** at the external eye corner to the angle of the mandible between the two groups showed varying results at different time points. **Pre-operatively**, both groups had similar mean swelling, with **Group A** showing a mean of **11.375** and **Group B** having a mean of **11.350**, and the difference was found to be **non-significant** with a **p-value of 0.950**. However, on the **2nd day** post-operation, **Group A** exhibited a slightly higher mean swelling of **11.850**, compared to **Group B's** mean of **11.688**, with a **p-value of 0.750**, indicating a **significant** difference in swelling between the groups at this time point. On the **7th day**, the swelling in **Group A** had decreased slightly to

11.475, while **Group B** had a mean of **11.363**, with a **p-value of 0.820**, which also showed a **significant** difference in swelling between the two groups. Overall, while there was some fluctuation in swelling over time, both groups had comparable swelling in the pre-operative phase, but **Group A** showed slightly higher swelling post-operatively.

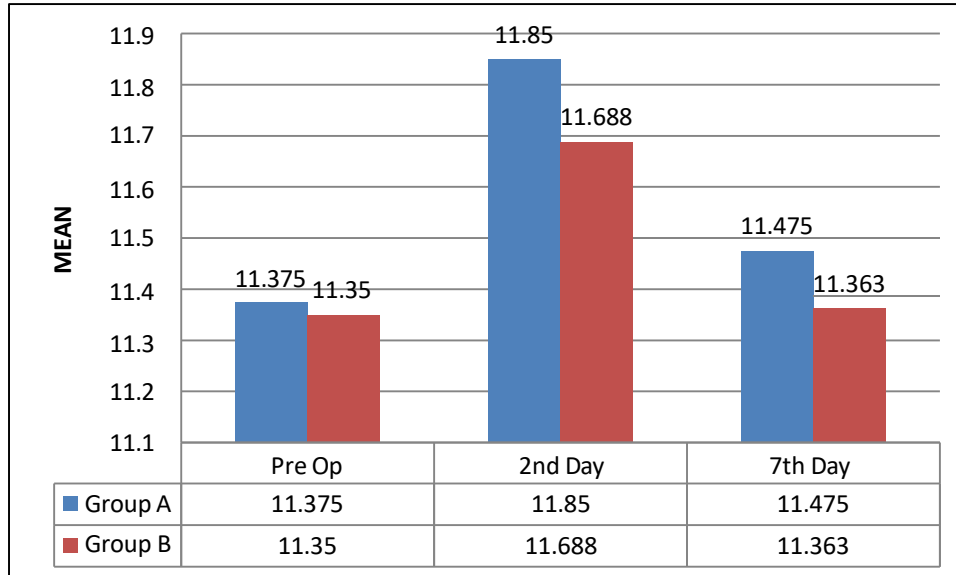


TABLE 7 - INTRAGROUP COMPARIOSN OF SWELLING AT EXTERNAL EYE CORNER TO ANGLE OF MANDIBLE BETWEEN DIFFERENT TIME INTERVALS

Group	Time Point	Mean	Std. Dev	Std. Error
Group A	Pre Op	11.375	1.103	0.390
	2nd Day	11.850	1.177	0.416
	7th Day	11.475	1.103	0.390
Group B	Pre Op	11.350	0.805	0.285
	2nd Day	11.688	0.774	0.273
	7th Day	11.363	0.812	0.287

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit.

Post Hoc Table

Group	Time Point Comparison	Mean Difference	Std. Error	P Value	Significance
Group A	Pre Op vs. 2nd Day	0.475	0.431	0.001	Significant
	Pre Op vs. 7th Day	-0.100	0.431	0.346	Non-Significant
	2nd Day vs. 7th Day	-0.575	0.431	0.001	Significant
Group B	Pre Op vs. 2nd Day	0.338	0.387	0.001	Significant
	Pre Op vs. 7th Day	0.013	0.387	0.876	Non-Significant
	2nd Day vs. 7th Day	-0.325	0.387	0.001	Significant

The **intragroup comparison of swelling** at the external eye corner to the angle of the mandible between different time intervals revealed some significant changes within each group. In **Group A** (Conventional Rotary Instrument), there was a **significant increase** in swelling from **pre-operative** to **2nd day**, with a mean difference of **0.475** ($p = 0.001$). However, no significant change was observed from **pre-operative** to **7th day** (mean difference of -0.100 , $p = 0.346$), though there was a **significant decrease** in swelling from **2nd day** to **7th day**, with a mean difference of -0.575 ($p = 0.001$). In **Group B** (Piezo Surgery Device and Piezo Elevator), swelling increased significantly from **pre-operative** to **2nd day**, with a mean difference of **0.338** ($p = 0.001$). However, there was no significant change from **pre-operative** to **7th day** (mean difference of 0.013 , $p = 0.876$), though swelling decreased significantly from **2nd day** to **7th day** (mean difference of -0.325 , $p = 0.001$). These findings indicate that swelling peaked at the **2nd day** post-operation in both groups but showed a reduction by the **7th day**, with some differences

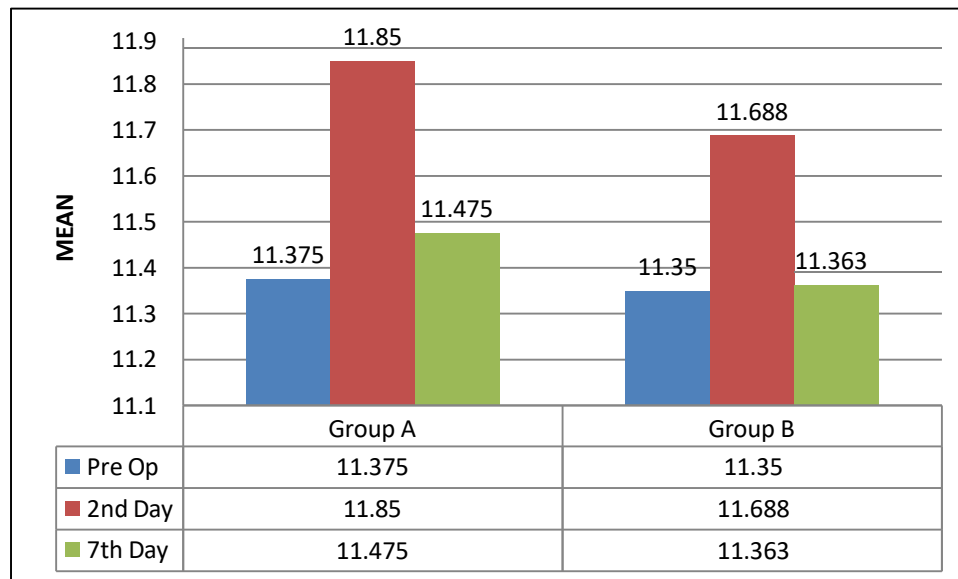


TABLE 8 - INTERGROUP COMPARISON OF SWELLING AT INTERNAL EYE CORNER TO ANGLE OF MANDIBLE BETWEEN THE GROUPS

		Mean	Std Dev	Std Error	P value	Significance
Pre Op	Group A	13.388	1.158	0.409	0.920	Non-Significant
	Group B	13.325	1.289	0.456		
2 nd Day	Group A	13.650	2.955	1.045	0.816	Non-Significant
	Group B	13.588	1.268	0.448		
7 th Day	Group A	13.500	1.146	0.405	0.796	Non-Significant
	Group B	13.338	1.309	0.463		

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit

The comparison of **swelling at the internal eye corner to the angle of the mandible** between the two groups revealed no statistically significant differences at any time point. **Pre-operatively**, both groups had nearly identical swelling measurements, with **Group A** showing a mean of **13.388** and **Group B** having a mean of **13.325**, and the difference between the groups was found to be **non-significant** ($p = 0.920$). On the **2nd day** post-operation, **Group A** had a mean swelling of **13.650**, while **Group B** had a slightly higher mean of **13.588**, but the difference was again **non-significant** ($p = 0.816$). Similarly, on the **7th day**, **Group A** showed a mean swelling of **13.500**, compared to **Group B's** mean

of **13.338**, with the difference remaining **non-significant** ($p = 0.796$). These results indicate that, across all time points, the swelling at the internal eye corner to the angle of the mandible was comparable between the two groups

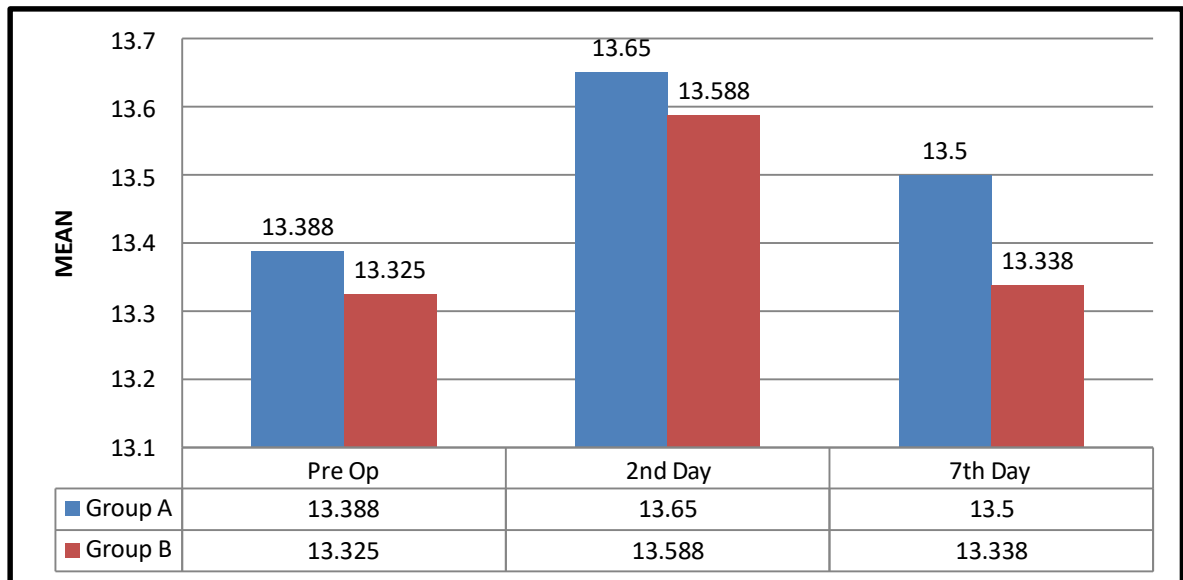


TABLE 9 - INTRAGROUP COMPARISON OF SWELLING AT INTERNAL EYE CORNER TO ANGLE OF MANDIBLE BETWEEN THE TIME INTERVALS

Group	Time Point	Mean	Std. Dev	Std. Error
Group A	Pre Op	13.388	1.158	0.409
	2nd Day	13.650	2.955	1.045
	7th Day	13.500	1.146	0.405
Group B	Pre Op	13.325	1.289	0.456
	2nd Day	13.588	1.268	0.448
	7th Day	13.338	1.309	0.463

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit

Post Hoc Comparison

Group	Time Point Comparison	Mean Difference	Std. Error	p Value	Significance
Group A	Pre Op vs. 2nd Day	-0.262	1.395	0.001	Significant
	Pre Op vs. 7th Day	0.112	1.395	0.145	Non-Significant
	2nd Day vs. 7th Day	0.850	1.395	0.001	Significant
Group B	Pre Op vs. 2nd Day	0.263	1.472	0.001	Significant
	Pre Op vs. 7th Day	0.013	1.472	0.876	Non-Significant
	2nd Day vs. 7th Day	-0.250	1.472	0.001	Significant

The **intragroup comparison of swelling at the internal eye corner to the angle of the mandible** revealed significant differences in swelling for both groups at certain time points. For **Group A** (Conventional Rotary Instrument), swelling was significantly higher on the **2nd day** (mean = 13.650) compared to **pre-op** (mean = 13.388) ($p = 0.001$), but the difference between **pre-op** and **7th day** (mean = 13.500) was **non-significant** ($p = 0.145$). Swelling was significantly reduced from the **2nd day** to the **7th day** (mean difference = 0.850, $p = 0.001$). In **Group B** (Piezo Surgery Device and Piezo Elevator), swelling significantly increased from **pre-op** (mean = 13.325) to the **2nd day** (mean = 13.588) ($p = 0.001$), but there was no significant difference between **pre-op** and **7th day** (mean = 13.338) ($p = 0.876$). A significant reduction in swelling was observed from the **2nd day** to the **7th day** (mean difference = -0.250, $p = 0.001$). These results suggest that both groups experienced an increase in swelling initially, but swelling decreased significantly by the **7th day** in both groups.

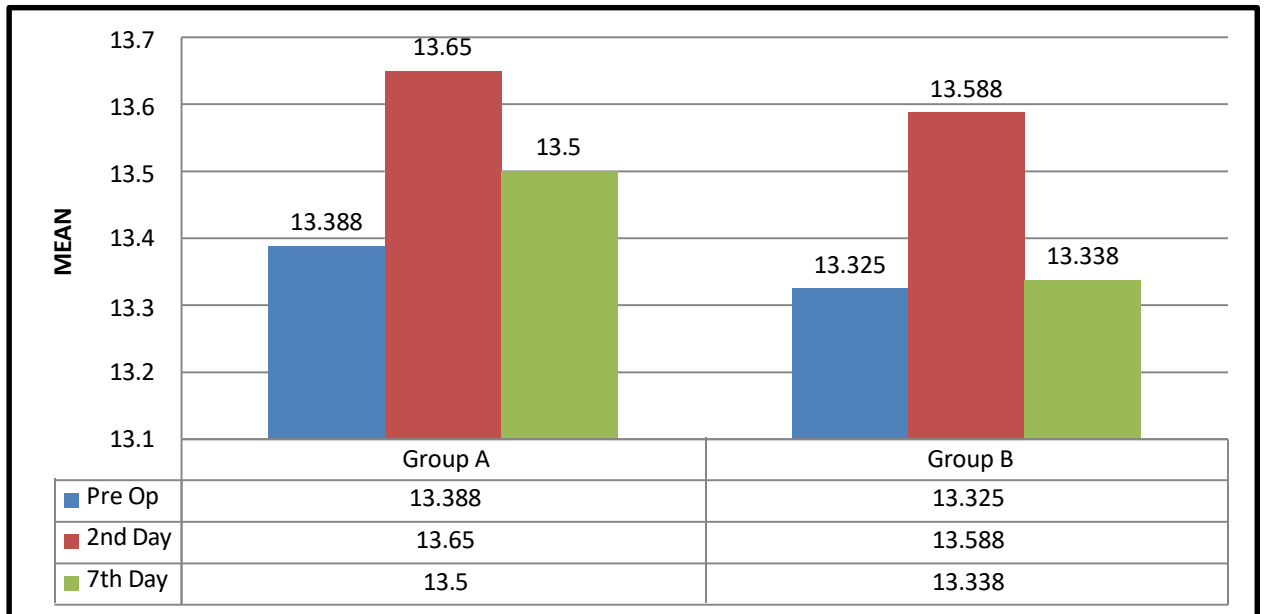


TABLE 10 - INTERGROUP COMPARISON OF SWELLING AT EXTERNAL EYE CORNER TO MENTAL PROTUBERANCE BETWEEN THE GROUPS

		Mean	Std Dev	Std Error	P value	Significance
Pre Op	Group A	12.088	0.544	0.192	0.484	Non-Significant
	Group B	11.825	0.878	0.310		
2 nd Day	Group A	12.338	3.628	1.283	0.715	Non-Significant
	Group B	12.138	0.872	0.308		
7 th Day	Group A	12.138	0.616	0.218	0.494	Non-Significant
	Group B	11.888	0.859	0.304		

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit.

The **intergroup comparison of swelling** at the external eye corner to the mental protuberance across different time points showed no significant differences between the two groups. **Pre-operatively**, both groups had similar swelling, with **Group A** showing a mean of **12.088** and **Group B** having a mean of **11.825**, and the difference was found to be **non-significant** ($p = 0.484$). On the **2nd day** post-operation, **Group A** had a mean swelling of **12.338**, while **Group B** had a mean of **12.138**, but the difference between the

groups remained **non-significant** ($p = 0.715$). Similarly, on the **7th day**, **Group A** showed a mean swelling of **12.138**, compared to **Group B's** mean of **11.888**, with the difference again being **non-significant** ($p = 0.494$). These results suggest that the swelling at the external eye corner to the mental protuberance was comparable between the two groups at all time points.

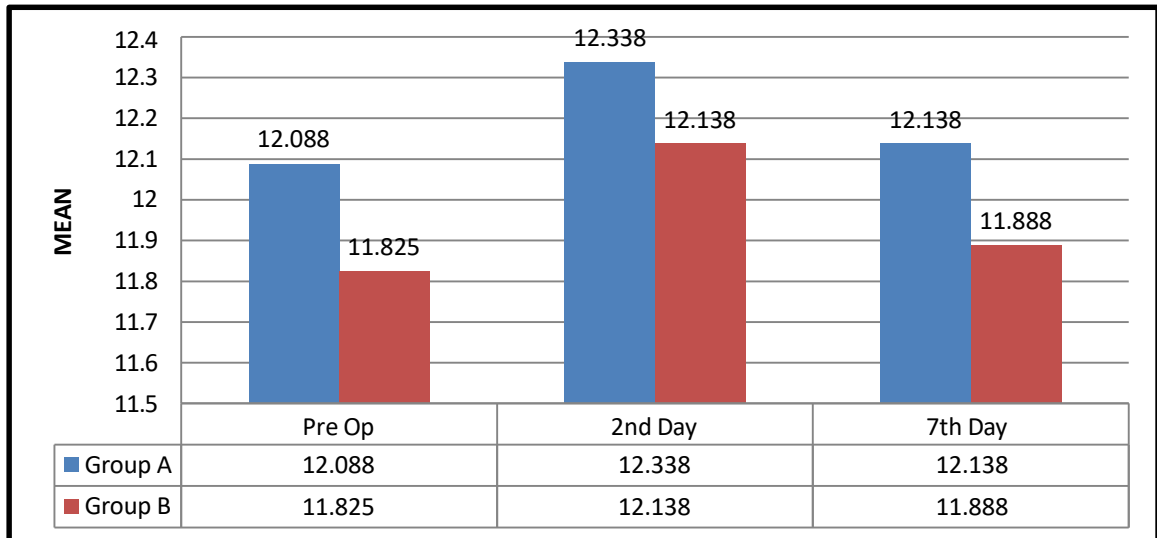


TABLE 11 - INTRAGROUP COMPARISON OF SWELLING AT AT EXTERNAL EYE CORNER TO MENTAL PROTUBERANCE BETWEEN THE TIME INTERVALS

Group	Time Point	Mean	Std. Dev	Std. Error
Group A	Pre Op	12.088	0.544	0.192
	2nd Day	12.338	3.628	1.283
	7th Day	12.138	0.616	0.218
Group B	Pre Op	11.825	0.878	0.310
	2nd Day	12.138	0.872	0.308
	7th Day	11.888	0.859	0.304

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit

Post Hoc Comparison

Group	Time Point Comparison	Mean Difference	Std. Error	P Value	Significance
Group A	Pre Op vs. 2nd Day	0.330	1.473	0.001	Significant
	Pre Op vs. 7th Day	0.050	1.473	0.912	Non-Significant
	2nd Day vs. 7th Day	0.800	1.473	0.001	Significant
Group B	Pre Op vs. 2nd Day	0.313	1.188	0.001	Significant
	Pre Op vs. 7th Day	0.063	1.188	0.657	Non-Significant
	2nd Day vs. 7th Day	-0.250	1.188	0.006	Significant

The **intragroup comparison of swelling at the external eye corner to mental protuberance** showed significant changes in swelling across different time intervals for both groups. In **Group A** (Conventional Rotary Instrument), there was a significant increase in swelling from **pre-op** (mean = 12.088) to the **2nd day** (mean = 12.338) ($p = 0.001$), followed by a significant decrease in swelling from the **2nd day** to the **7th day** (mean = 12.138) ($p = 0.001$). However, the difference between **pre-op** and **7th day** was **non-significant** ($p = 0.912$). In **Group B** (Piezo Surgery Device and Piezo Elevator), swelling significantly increased from **pre-op** (mean = 11.825) to the **2nd day** (mean = 12.138) ($p = 0.001$), with a significant decrease from the **2nd day** to the **7th day** (mean = 11.888) ($p = 0.006$). No significant difference was found between **pre-op** and **7th day** ($p = 0.657$). Overall, both groups exhibited significant changes in swelling over the post-operative period, with Group A showing a notable decrease from the **2nd day** to the **7th day**, while Group B also demonstrated a significant reduction in swelling by the **7th day**.

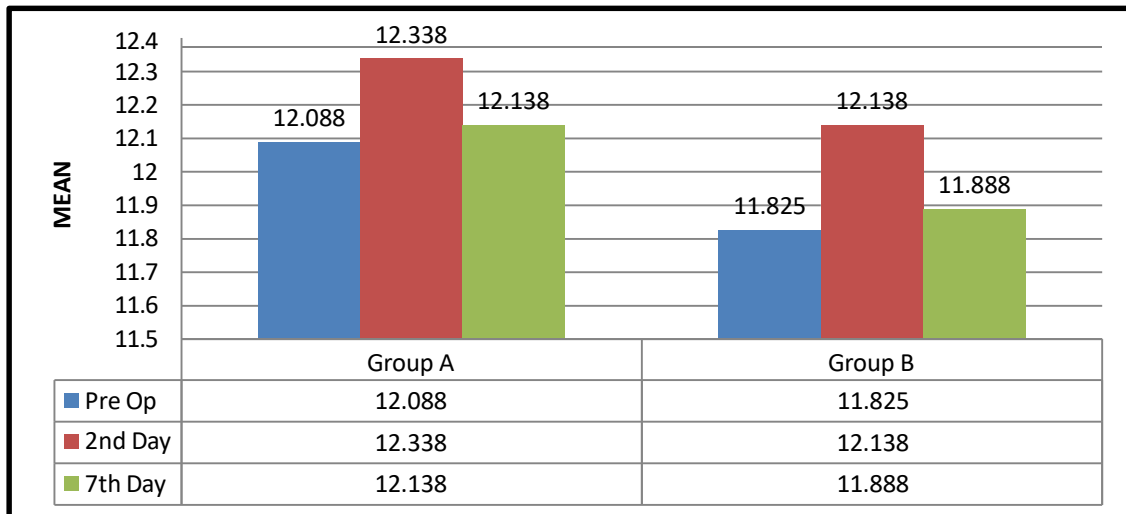


TABLE 12 - INTERGROUP COMPARISON OF PAIN BETWEEN THE GROUPS

		Mean	Std Dev	Std Error	P value	Significance
Pre Op	Group A	0.000	0.000	0.000	1.000	Non-Significant
	Group B	0.000	0.000	0.000		
1st Hour	Group A	4.000	1.512	0.535	0.268	Non-Significant
	Group B	3.250	1.035	0.366		
1st Day	Group A	2.500	0.926	0.327	0.301	Non-Significant
	Group B	1.750	1.282	0.453		
7 th Day	Group A	0.250	0.707	0.250	0.453	Non-Significant
	Group B	0.000	0.000	0.000		

Group A –Conventional Rotary Instrument, Group B – Piezosurgical unit.

The **intergroup comparison of pain** between the two groups at different time points showed no significant differences. **Pre-operatively**, both groups reported no pain, as reflected by a mean score of **0.000** for both **Group A** and **Group B** ($p = 1.000$). During the **1st hour** post-operation, **Group A** reported a mean pain score of **4.000**, while **Group B** had a mean score of **3.250**; however, this difference was **non-significant** ($p = 0.268$). On the **1st day**, **Group A** had a mean pain score of **2.500**, and **Group B** reported a mean of **1.750**, with no significant difference between the groups ($p = 0.301$). By the **7th day**,

Group A experienced minimal pain (mean score of **0.250**), while **Group B** had no pain (mean score of **0.000**), but again, this difference was not statistically significant ($p = 0.453$).

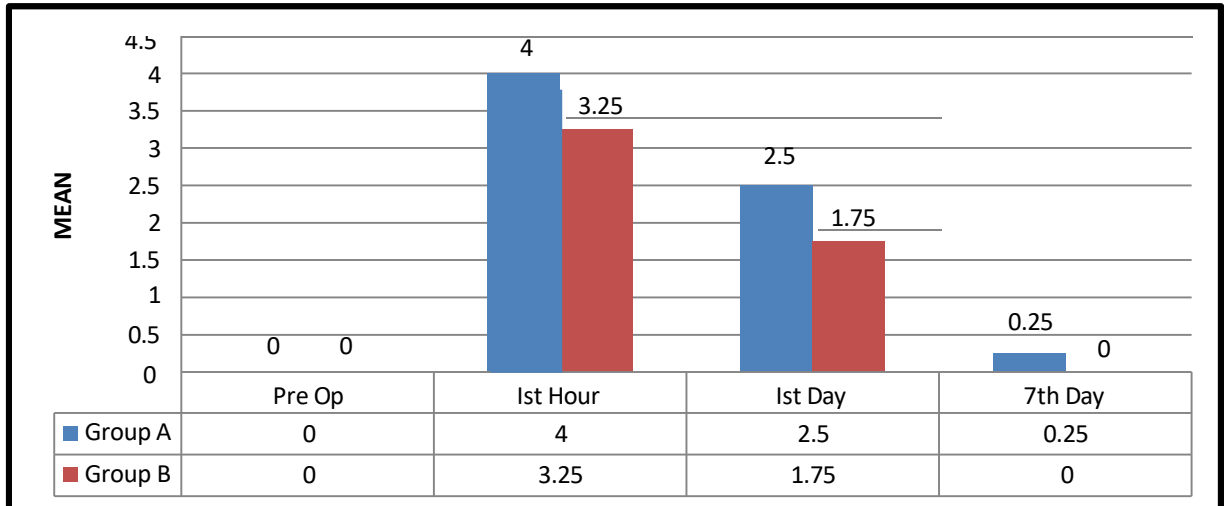


**TABLE 13 - INTRAGROUP COMPARISON OF MEAN PAIN SCORES
BETWEEN DIFFERENT TIME INTERVALS**

Group	Time Point	Mean	Std. Dev	Std. Error
Group A	Pre Op	0.000	0.000	0.000
	1st Hour	4.000	1.512	0.535
	1st Day	2.500	0.926	0.327
	7th Day	0.250	0.707	0.250
Group B	Pre Op	0.000	0.000	0.000
	1st Hour	3.250	1.035	0.366
	1st Day	1.750	1.282	0.453
	7th Day	0.000	0.000	0.000

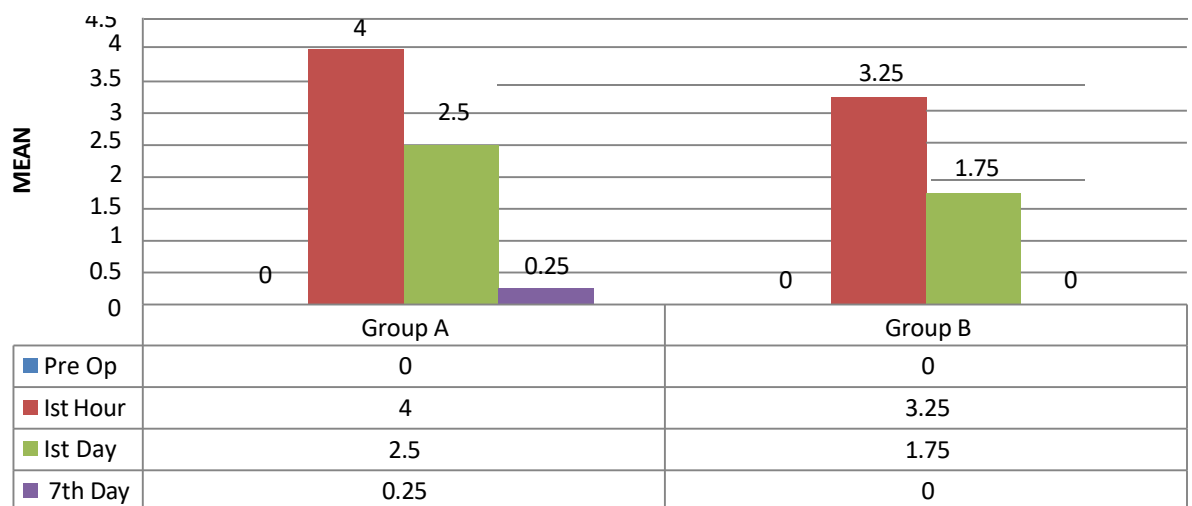
Group A –Conventional Rotary Instrument, Group B - Piezo Surgery Device And Piezo Elevator

Post Hoc Table

Group	Comparison	Mean Difference	Std. Error	P Value	Significance
Group A	Pre Op vs. 1st Hour	4.000	1.512	0.001	Significant
	Pre Op vs. 1st Day	2.500	0.926	0.001	Significant
	Pre Op vs. 7th Day	0.250	0.707	0.001	Significant
	1st Hour vs. 1st Day	-1.500	1.566	0.016	Significant
	1st Hour vs. 7th Day	-3.750	1.566	0.001	Significant
	1st Day vs. 7th Day	-2.250	1.566	0.001	Significant
Group B	Pre Op vs. 1st Hour	3.250	1.035	0.001	Significant
	Pre Op vs. 1st Day	1.750	1.282	0.005	Significant
	Pre Op vs. 7th Day	0.000	0.000	1.000	Non-Significant
	1st Hour vs. 1st Day	-1.500	1.566	0.016	Significant
	1st Hour vs. 7th Day	-3.250	1.512	0.001	Significant
	1st Day vs. 7th Day	-1.750	1.595	0.005	Significant

The **intragroup comparison of mean pain scores** between different time intervals showed significant changes in pain levels within both groups. In **Group A** (Conventional Rotary Instrument), there was a significant increase in pain from **pre-op** (mean = 0.000) to the **1st hour** (mean = 4.000), and significant decreases in pain from **1st hour** to **1st**

day (mean difference = -1.500, $p = 0.016$), and from **1st day** to **7th day** (mean difference = -2.250, $p = 0.001$). Similarly, in **Group B** (Piezo Surgery Device and Piezo Elevator), pain increased significantly from **pre-op** (mean = 0.000) to **1st hour** (mean = 3.250), and significantly decreased from **1st hour** to **1st day** (mean difference = -1.500, $p = 0.016$) and from **1st day** to **7th day** (mean difference = -1.750, $p = 0.005$). However, the pain score remained **0.000** at the **7th day** in **Group B**, indicating no further pain by this time. These results indicate that both groups experienced significant pain initially, but this pain decreased significantly over time, with Group A showing a gradual decrease and Group B reporting no pain by the 7th day.



STATISTICAL ANALYSIS

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation frequency and percentage. The level of the significance for the present study was fixed at 5%.

The intergroup comparison will be done using the independent t tests/Mann Whitney U test and intragroup comparison between time intervals was done using the Repeated measures ANOVA followed by Post Hoc Analysis The ordinal variable were compared using the Chi square test The Shapiro–Wilk test was used to investigate the distribution of the data

Mean

$$\bar{X} = \frac{\sum X}{N}$$

Where:

$\bar{X}$ = the data set mean

$\sum$ = the sum of

X = the scores in the distribution

N = the number of scores in the distribution

Range

$$range = X_{highest} - X_{lowest}$$

Where:

$X_{highest}$ = largest score

X_{lowest} = smallest score

Variance

$$SD^2 = \frac{\Sigma(X - \bar{X})^2}{N}$$

The simplified variance formula

$$SD^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}$$

Where:

SD^2 = the variance

Σ = the sum of

X = the obtained score

$\bar{X}$ = the mean score of the data

N = the number of scores

Standard Deviation (N)

$$SD = \sqrt{\frac{\Sigma(X - \bar{X})^2}{N}}$$

The simplified standard deviation formula

$$SD = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}}$$

Where:

SD = the standard deviation

Σ = the sum of

X = the obtained score

$\bar{X}$ = the mean score of the data

N = the number of scores

Independent t-test

Independent t Test can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution. The independent samples t -test is used when two separate sets of independent and identically distributed samples are obtained, one from each of the two populations being compared

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2} \right) \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}}$$

Where X_1 =Mean of the first Group, X_2 =Mean of the Second Group

Chi Square Test

Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. When an analyst attempts to fit a statistical model to observed data, he or she may wonder how well the model actually reflects the data. How "close" are the observed values to those which would be expected under the fitted model? One statistical test that addresses this issue is the chi-square goodness of fit test. This test is commonly used to test association of variables in two-way tables, where the assumed model of independence is evaluated against the observed data. In general, the ***chi-square test statistic*** is of the form

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}.$$

If the computed test statistic is large, then the observed and expected values are not close and the model is a poor fit to the data

One Way ANOVA

The formula for the one-way **ANOVA** *F*-test statistic is

$$F = \frac{\text{between-group variability}}{\text{within-group variability}}.$$

The "between-group variability" is

$$\sum_{i=1}^K n_i (\bar{Y}_{i\cdot} - \bar{Y})^2 / (K - 1)$$

where $\bar{Y}_{i\cdot}$ denotes the sample mean in the i^{th} group, n_i is the number of observations in the i^{th} group, $\bar{Y}$ denotes the overall mean of the data, and K denotes the number of groups.

The "within-group variability" is

$$\sum_{i=1}^K \sum_{j=1}^{n_i} (Y_{ij} - \bar{Y}_{i\cdot})^2 / (N - K),$$

where Y_{ij} is the j^{th} observation in the i^{th} out of K groups and N is the overall sample size.

DISCUSSION

Sinus lift procedures have emerged as vital interventions for the rehabilitation of the atrophic posterior maxilla, where anatomical limitations such as reduced alveolar bone height often pose significant challenges to predictable implant placement. Augmentation of the maxillary sinus not only restores adequate bone volume but also facilitates the placement of longer and more stable implants, thereby improving long-term prosthetic outcomes. Given the clinical importance of maximizing surgical predictability and minimizing patient morbidity in implant-related procedures, the present study aimed to compare and evaluate the outcomes of direct sinus lift surgeries performed using conventional rotary instruments vs piezoelectric devices.³⁹ The assessment focused on five parameters—operative time, surgical site visibility, sinus membrane perforation, postoperative swelling, and pain—each of which plays a pivotal role in the overall success of the procedure and patient recovery. This comparative approach was intended to provide insights into how these two commonly used techniques differ in both surgical efficiency and postoperative outcomes, thereby assisting clinicians in selecting the most appropriate modality for various clinical scenarios.

Among the various clinical indicators considered in this analysis, operative time was particularly important due to its practical implications for both clinicians and patients. A shorter surgical duration can reduce intraoperative stress, minimize exposure-related complications, and streamline clinical workflow. Moreover, it directly affects patient experience, especially in procedures requiring local anesthesia, where prolonged duration may increase discomfort and anxiety. As such, understanding how each technique influences the time taken to complete the procedure offers valuable insight in terms of applicability and efficiency. In the current study, the mean operative time recorded using the piezoelectric technique was 23.375 ± 2.615 minutes, significantly longer than the 16.625 ± 1.685 minutes observed in the rotary group ($p = 0.001$). Similar findings were reported by Barone et al. (2008)⁵, who observed that sinus lifts with piezosurgery required more time than those using rotary instruments, with mean durations of approximately 28 minutes and 22 minutes respectively. Coherent results were observed in the study by Rickert et al.⁸, where average durations were 24.2 ± 2.3 minutes for

piezoelectric and 17.3 ± 1.9 minutes for rotary burs. Likewise, Wallace et al. (2007)³⁹ reported a significantly higher mean time (25.4 ± 3.6 minutes) for piezo compared to 18.9 ± 2.7 minutes for rotary methods. The longer procedural duration associated with piezoelectric surgery, attributing it to the meticulous and controlled bone removal process it requires. Although prolonged surgical time may appear as a disadvantage, the increased duration is clinically justified by the greater precision, improved tactile control, and enhanced safety provided by the piezoelectric device.⁴⁰ This method necessitates multiple, controlled passes to achieve accurate bone cutting and maintain anatomical integrity, particularly near delicate structures such as the Schneiderian membrane. Thus, while the conventional technique remains advantageous in terms of procedural efficiency, the piezoelectric system may offer critical benefits in reducing complications and improving surgical outcomes, especially in anatomically complex cases.

The study also examined the visibility of the surgical field during the sinus lift procedure. Although the differences in operator visibility scores between the groups were not statistically significant ($p = 0.819$), the piezoelectric group demonstrated marginally better scores, with a mean of 2.750 compared to 2.625 in the rotary group. This finding may be attributed to the cavitation effect produced by piezosurgery, which minimizes intraoperative bleeding and thereby enhances the clarity of the operative field. In our study, this could be ascribed to controlled flap reflection in combination with piezo's integrated irrigation system and minimal vascular disruption. These properties enables steady cooling and localized hemostasis, resulting in a clearer surgical field. The results are coherent with the study Dellibasi et al.¹¹ in which there was no statistically difference was seen ($P=0.144$) and concluded that it maintains clear field due to air water cavitation effect. Another study by Toscano et al.⁷ emphasized that the improved visualization facilitated by piezosurgery contributes significantly to safer membrane elevation and a reduced risk of perforation, particularly in anatomically challenging scenarios. The ability to maintain a cleaner and more visible surgical site is an added advantage of piezoelectric systems, allowing for more accurate manipulation and improved handling of the delicate sinus membrane.

One of the most critical concerns during sinus lift surgery is the risk of Schneiderian membrane perforation.⁴² In the present study, sinus membrane perforation occurred in 25% of the cases (2 out of 8) in the conventional rotary instrument group, while no perforations (0%) were observed in the piezoelectric group. Although this difference was not statistically significant ($p = 0.233$), the clinical implications are profound. Similar results were present in the study by Jordi et al.¹⁶, who reported a reduction in membrane perforation rates from 24% with rotary instruments to 8% with piezoelectric devices. Likewise, results of Seoane et al.³⁹ were similar and concluded that the use of piezoelectric devices substantially reduced the risk of membrane perforation, particularly in surgeries performed by less experienced operators. The selective cutting mechanism of piezoelectric units, which preferentially targets mineralized tissue while sparing adjacent soft tissues, plays a pivotal role in preserving the integrity of the Schneiderian membrane.⁴³ In the current study, the two perforations in the conventional group were managed using resorbable collagen membranes. However, the process of repairing membrane perforations can be technically demanding, and the risk of surgical failure remains if graft containment is compromised. An intact sinus membrane is essential for maintaining graft stability and preventing potential postoperative infections, underscoring the importance of using surgical modalities that minimize the risk of perforation.

Another parameter investigated was postoperative swelling. Swelling was measured using multiple anatomical reference points, including the external and internal eye corners to the angle of the mandible, as well as the mental protuberance.³⁷ No statistically significant differences were observed between the two groups across all time intervals—preoperatively, on the second day, and on the seventh day postoperatively. For instance, at the external eye corner to the angle of mandible, swelling on Day 2 was slightly higher in Group A 11.850 ± 1.177 mm than in Group B 11.688 ± 0.774 mm ($p = 0.750$). By Day 7, the swelling decreased to 11.475 ± 1.103 mm in Group A and 11.363 ± 0.812 mm in Group B ($p = 0.820$). At the external eye corner to mental protuberance, swelling on Day 2 was slightly higher in Group A 13.65 ± 2.955 mm than in Group B 12.138 ± 0.872 mm ($p = 0.79$). By Day 7, the swelling decreased to 12.138 ± 0.616 mm in Group A and 11.88 ± 0.859 mm in Group B ($p = 0.494$). At the internal eye corner to angle of mandible,

swelling on Day 2 was almost similar in both groups, Group A $13.65 \pm 2.955\text{mm}$ and Group B $13.588 \pm 1.268\text{ mm}$ ($p = 0.816$). By Day 7, the swelling in both the group has reduced $13.500 \pm 1.146\text{ mm}$ in Group A and $13.338 \pm 1.309\text{ mm}$ in Group B ($p = 0.796$). Both groups exhibited a similar pattern, with peak swelling occurring on the second postoperative day followed by gradual regression by the seventh day. These result are in coherent with previous study by Shahakbari et al. (2020)¹⁸ who recorded mean swelling of $5.4 \pm 0.9\text{ mm}$ with piezosurgery and $6.1 \pm 1.0\text{ mm}$ with rotary instruments on day two., found no significant differences in objective swelling measurements between the two techniques, though subjective comfort was higher in the piezo group. Martins et al. (2021)¹⁹ in a split-mouth study reported postoperative swelling of $4.9 \pm 0.7\text{ mm}$ on the piezo side and $6.0 \pm 0.8\text{ mm}$ on the rotary side. It was noted that while swelling levels were objectively comparable, patients reported reduced discomfort and trismus with piezoelectric surgery. The similar swelling profiles in our study suggest that the surgical trauma associated with both techniques was equivalent in terms of eliciting a physiological inflammatory response. However, the marginally lower swelling observed in the piezo group could be related to the reduced mechanical insult and more conservative tissue handling inherent to ultrasonic bone cutting. The cavitation effect and minimal thermal generation associated with piezoelectric devices likely contribute to a less aggressive inflammatory reaction.

Pain was assessed using the Wong-Baker pain rating scale, and both groups reported peak pain levels within the first postoperative hour. Group A (conventional rotary instruments) recorded a mean pain score of 4.000 ± 1.512 , while Group B (piezoelectric instruments) had a lower mean of 3.250 ± 1.035 ($p = 0.268$). On the first postoperative day, Group A had a mean pain score of 2.500 ± 0.926 , while Group B had a lower mean score of 1.750 ± 1.282 ($p = 0.301$). By the seventh day, pain had almost completely resolved in both groups, with the piezo group reporting no pain (mean = 0.000 ± 0.000) and the conventional group reporting minimal discomfort (mean = 0.250 ± 0.707) ($p = 0.453$). Results were coherent with study of Gad El-Hak et al.²⁹, who reported significantly lower postoperative pain levels following piezoelectric surgery. The underlying cause is likely the minimally invasive nature of piezoelectric bone cutting, which results in less thermal damage, reduced mechanical trauma, and preservation of soft tissues.⁵⁰ These features

contribute to a lower nociceptive response and promote more favorable postoperative healing. The reduced pain and swelling associated with piezoelectric procedures may enhance patient satisfaction and compliance, making it a preferred option in cases where patient comfort is a priority.

A total of 19 implants were placed across the two study groups. In three cases bone grafting was required at the time of implant placement, to achieve satisfactory primary stability. Despite these anatomical limitations, all implants achieved adequate insertion torque (30Ncm to 40 Ncm), supporting the clinical feasibility of simultaneous implant placement during sinus augmentation. Six month followup assessments using CBCT demonstrated successful outcomes in all patients ,with no evidence of implant failure. Taken together, the present study demonstrates that both conventional and piezoelectric approaches to sinus lift surgery are clinically viable, with each having its own advantages and limitations. The conventional rotary technique is characterized by reduced operative time and widespread availability, making it a practical choice for many clinical settings. However, it carries a higher risk of membrane perforation and may be associated with increased postoperative discomfort. In contrast, piezoelectric surgery, though associated with longer operative durations and higher costs, offers significant advantages in terms of surgical safety, intraoperative visibility, reduced membrane perforation risk, and improved patient-reported outcomes.⁵² These benefits are particularly relevant in anatomically complex scenarios or when managing patients with heightened sensitivity to pain.

Nonetheless, certain limitations of the study must be acknowledged. The relatively small sample size limits the generalizability of the findings to broader populations. While preoperative CBCT imaging was employed to ensure precise anatomical evaluation and surgical planning, dynamic postoperative radiographic assessments to monitor graft maturation and long-term bone remodeling were beyond the scope of this study. Additionally, the study focused primarily on short-term clinical outcomes such as membrane perforation, operative time, swelling, and pain, while long-term indicators including implant survival rates, marginal bone loss, and patient-reported quality of life were not evaluated. Minor variations in surgical technique and inter-individual anatomical differences may also have influenced the results. Future research should aim

to address these limitations by conducting multicenter, prospective studies with larger sample sizes, longer follow-up periods, and comprehensive postoperative assessments, including radiographic analysis and standardized patient satisfaction indices. Such studies would provide more robust evidence and inform clinical decision-making for optimizing sinus lift protocols and improving patient outcomes in implant dentistry.

CONCLUSION

In conclusion, this study has provided a comprehensive evaluation of the effectiveness of conventional rotary instruments versus piezoelectric devices in sinus lift procedures for the atrophic posterior maxilla. Both techniques are clinically viable, yet they offer distinct advantages that can guide clinical decision-making. The conventional rotary method is efficient and time-saving, making it suitable for high-volume practices. However, it presents a higher risk of complications, particularly Schneiderian membrane perforation, which is a critical concern during these procedures. Conversely, piezoelectric devices, while requiring longer surgical durations, enhance safety and precision. Their ability to minimize the risk of membrane perforation and improve visibility during surgery is particularly beneficial in complex anatomical scenarios. Additionally, the trend towards lower postoperative discomfort associated with piezoelectric surgery indicates a potential for greater patient satisfaction, especially for those sensitive to pain. Despite the promising findings, this study acknowledges limitations, including a small sample size and a focus on short-term outcomes. Future research should aim to conduct larger, multicenter studies that explore long-term results and incorporate comprehensive assessments of patient quality of life. By addressing these gaps, the dental community can refine sinus lift protocols and ultimately enhance patient care in implant dentistry.

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ANNEXURE -I



BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES
(Faculty of BBD University, Lucknow)

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Comparison Of Piezosurgery And Coventional Rotary Instruments In Direct Sinus Lift Procedure."** submitted by **Dr. JAYA MAHATO** Postgraduate student in the **Department of Oral and Maxillofacial Surgery** for the Thesis Dissertation as part of MDS Curriculum for the academic year 2022-2025 with the accompanying proforma was reviewed by the Institutional Research Committee in its meeting held on **16th October, 2023** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.


(Prof. Dr. Puneet Ahuja)
 Chairperson (IRC)
 Principal
 BBD College of Dental Sciences
 BBD University, Lucknow


(Dr. Lakshmi Bala)
 Co-Chairperson (IRC)
 HOD Biochemistry
 BBD College of Dental Sciences
 BBD University, Lucknow.

ANNEXURE -II



BBD UNIVERSITY

Dr. Lakshmi Bala

Professor and Head, Deptt of Biochemistry and

Member-Secretary, Institutional Ethics Committee (IEC) of BBD University, Lucknow

Communication of the Decision of the VIIIth Institutional Ethics Committee Meeting

IEC Code: 16

BBDU/MDS/16/2024

Date: 07/03/2024

Title of the Project: Comparison Of Piezosurgery And Coventional Rotary Instruments In Direct Sinus Lift Procedure

Principal Investigator: Dr. JAYA MAHATO**Department:** Department of Oral and Maxillofacial Surgery**Name and Address of the Institution:** BBD University, Lucknow**Type of Submission:** New, MDS Dissertation proposal

Dear Dr. Jaya Mahato

The meeting of the Institutional Ethics Committee (IEC) was held on 06-02-2024 in Conference room, First Floor, BBDCODS, BBD University, Lucknow. Following members were present:

- | | | |
|---|--|------------------|
| 1 | Dr. Chandishwar Nath
Rtd. Chief Scientist, CDRI, Lucknow. | Chairman |
| 2 | Dr. JS Srivastava,
Rtd. Chief Scientist, CDRI, Lucknow. | Member |
| 3 | Dr. Manodeep Sen,
Professor, Department of Microbiology, RMLIMS, Lucknow | Member |
| 4 | Dr. Shaleen Chandra, Professor & Dean, Dental Sciences, Atal Bihari Vajpai Medical University (ABVM University), Lucknow | Member |
| 5 | Dr. Manuka Khanna,
Professor, Deptt. of Political Science, Lucknow University, Lucknow | Member |
| 6 | Mr Abhishek Chaudhary, Advocate, Lucknow | Member |
| 7 | Dr. Puneet Ahuja, Professor of Oral Pathology and Principal, BBD College of Dental Sciences, BBD University, Lucknow | Member |
| 8 | Dr. Lakshmi Bala, Professor & Head, Department of Biochemistry, BBD College of Dental Sciences, BBD University, Lucknow | Member-Secretary |

The committee reviewed and discussed your submitted documents of the research proposal in the meeting. Following comments were suggested and communicated.

Comments:

1. In protocol and PID include "Randomization of participant" for 'two different procedures' and "NO extra cost will be borne by participants for opting any one of the procedures. Thereafter, the proposal was revised by Principal Investigator and duly approved by the Supervisor and Head of the Department.

Decisions: The committee approved the above proposal from ethics point of view.

Lakshmi Bala
07/03/24
(Dr. Lakshmi Bala)
Member-Secretary IEC
BBD University
Ethics Cell (Vth Floor, BBDCODS)
ethics@bbdu.ac.in

Dr. LAKSHMI BALA
Member-Secretary
Institutional Ethics Committee
BBD University, Lucknow-28

ANNEXURE -III

**Babu Banarasi Das College of Dental
Sciences**

(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105
(INDIA)

सहमति पत्र

अध्ययन का शीर्षक: प्रत्यक्ष साइनस लिफ्ट प्रक्रिया में पारंपरिक रोटरी और पीजोइलेक्ट्रिक दृष्टिकोण का तुलनात्मक मूल्यांकन।

स्टडी नंबर.....

विषय का पूरा नाम

जन्म तिथि/आयु

विषय का पता.....

फोन नंबर। और ई-मेल पता

योग्यता

व्यवसाय: छात्र / स्वरोजगार / सेवा / गृहिणी / अन्य (कृपया उपयुक्त के रूप में टिक करें)

विषय की वार्षिक आय.....

नाम और नामांकित व्यक्ति (ओं) और विषय के साथ उसका संबंध (के प्रयोजन के लिए)

मुकदमे से संबंधित मौत के मामले में मुआवजा।

1. मैं पुष्टि करता हूँ कि मैंने प्रतिभागी सूचना दस्तावेज दिनांक को पढ़ और समझ लिया है। उपरोक्त अध्ययन के लिए और प्रश्न पूछने का अवसर मिला है। या मुझे अन्वेषक द्वारा अध्ययन की प्रकृति के बारे में बताया गया है और मुझे प्रश्न पूछने का अवसर मिला है।
2. मैं समझता हूँ कि अध्ययन में मेरी भागीदारी स्वैच्छिक है और बिना किसी दबाव के स्वतंत्र इच्छा के साथ दी गई है और मैं बिना कोई कारण बताए और अपनी चिकित्सा देखभाल या कानूनी अधिकारों को प्रभावित किए बिना किसी भी समय वापस लेने के लिए स्वतंत्र हूँ।

- स्वीकार्य प्रतिनिधि

ANNEXURE -IV

**Babu Banarasi Das College of Dental
Sciences**
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105
(INDIA)

Consent Form (English)

Title of the Study: COMPARATIVE EVALUATION OF COVENTIONAL ROTARY
AND PIEZOSURGERY APPROACHES IN DIRECT SINUS LIFT PROCEDURE.

Study Number.....

Subject's Full Name.....

Date of Birth/Age

Address of the Subject.....

Phone no. and e-mail address.....

Qualification

Occupation: Student / Self Employed / Service / Housewife/

Other (Please tick as appropriate)

Annual income of the Subject.....

Name and of the nominees(s) and his relation to the subject.....(For the purpose
of compensation in case of trial related death).

1. I confirm that I have read and understood the Participant Information Document dated for the above study and have had the opportunity to ask questions. **OR** I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.
2. I understand that my participation in the study is voluntary and given with free will without any duress and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

5. I permit the use of stored sample (tooth/tissue/blood) for future research. **Yes** [] **No** []

Not Applicable []

6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the participant/volunteer's Information document given to me.

Signature (or Thumb impression) of the Subject/Legally

Acceptable Representative:

Signatory's Name..... Date

Signature of the Investigator..... Date.....

Study Investigator's Name..... Date.....

Signature of the witness..... Date.....

Name of the witness.....

Received a signed copy of the PID and duly filled consent form

Signature/thumb impression of the subject or legally

Date

.....

Acceptable representative

ANNEXURE -V

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

PARTICIPANT INFORMATION DOCUMENT**1. Study Title**

COMPARATIVE EVALUATION OF COVENTIONAL ROTARY AND PIEZOELECTRIC APPROACHES IN DIRECT SINUS LIFT PROCEDURE.

2. Invitation Paragraph

You are being invited to take part in a research/trial study. Before you decide it is important for you to understand why the research/study is being done and what it will involve. Please take time to read the following information carefully and discuss it with friends, relatives and your treating physician/family doctor if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

3. What is the purpose of the study?

The purpose of the study is to compare conventional rotary instruments and piezo surgery in direct sinus lift procedures.

4. Why have I been chosen?

You have been chosen for the study as you are fulfilling the required criteria for the study.

5. Do I have to take part?

Your participation in the research is entirely voluntary. If you do, you will be given this information sheet to keep and will be asked to sign a consent form. During the study, you are still free to withdraw at any time and without giving a reason.

6. What will happen to me if I take part?

You will have to come multiple times before and after surgery for follow up as and when required.

7. What do I have to do?

There will be certain changes made in the dietary intake with few other precautionary measures and you will be expected to follow that.

8. What is the procedure that is being tested?

Use of conventional and Piezo electric instruments in direct sinus lift Procedure.

9. What are the interventions for the study?

Direct Sinus Lift Procedure will be done using conventional and piezoelectric instruments followed by placement of grafts and implants.

10. What are the side effects of taking part?

Although there are no reports of serious side effects of the procedure but the participants may have

Page 1 of 5

minimum side effects of the drugs like nausea and post operative vomiting. If anything happens during the procedure we have skilled personnel and specialized equipments to manage any emergency. If the participants suffers any other symptoms postoperatively, the guardian should immediately talk to the doctor.

11. What are the possible disadvantages and risks of taking part?

There are no disadvantages of taking part in the study, there can be minimum side effects of the drugs.

12. What are the possible benefits of taking part?

Direct sinus lift procedure will enable placement of implant in posterior atrophic maxilla which will enhances functional efficiency.

13. What if new information becomes available?

If additional information becomes available during the course of the research you will need to tell the patient about this. States:

–Sometimes during the course of a research project, new information becomes available about the research being studied. If this happens, your researcher will tell you about it and discuss with you whether you want to continue in the study. If you decide to withdraw, your researcher/investigator will make arrangements for your withdrawal. If you decide to continue in the study, you may be asked to sign an updated consent form.

14. What happens when the research study stops?

Nothing will happen to the participants.

15. What if something goes wrong?

the problem/complain will be handled by HOD or the IRC. If something serious happen the institute will take care of the problem.

16. Will my taking part in this study be kept confidential?

Yes, it will be kept confidential.

17. What will happen to the results of the research study?

18. Who is organizing the research?

the research is being done in the department of Oral and Maxillofacial Surgery, BBDCODS. The research is self funded. The participants will have to pay for procedural charges as given by the institution.

19. Will the results of the study be made available after study is over?

Yes

20. Who has reviewed the study?

The HOD and the members of IRC/ IEC of the institution have reviewed and approved the study.

21. Contact for further information**Dr. Jaya Mahato**

Department of Oral & Maxillofacial Surgery.

Babu Banarasi College of Dental Sciences.

Lucknow-226028

Mob: 7247852712

Dr. Laxmi Bala

Dr Lakshmi Bala

Member-Secretary

Institutional Ethics Committee (IEC) of BBD University, Lucknow

Email: ethics@bbdu.ac.in

Phone no. 0522 6191091

Signature of PI.....

Name.....

Date.....

ANNEXURE -VI

**बाबू बनारसी दास कॉलेज ऑफ डेंटल साइंसेज
(बाबू बनारसी दास विश्वविद्यालय)
बीबीडी सिटी, फैजाबाद रोड, लखनऊ – 227105 (भारत)**

अध्ययन शीर्षक

प्रत्यक्ष साइनस लिफ्ट प्रक्रिया में पारंपरिक और पीजोइलेक्ट्रिक उपकरणों का उपयोग।

आमंत्रण पैराग्राफ

आपको एक शोध अध्ययन में भाग लेने के लिए आमंत्रित किया जा रहा है। निर्णय लेने से पहले आपके लिए यह समझना महत्वपूर्ण है कि शोध क्यों किया जा रहा है और इसमें क्या शामिल होगा। कृपया निम्नलिखित जानकारी को ध्यान से पढ़ने के लिए समय निकालें और यदि आप चाहें तो मित्रों, रिश्तेदारों और अपने इलाज करने वाले चिकित्सक/पारिवारिक चिकित्सक के साथ इस पर चर्चा करें। हमसे पूछें कि क्या कुछ ऐसा है जो स्पष्ट नहीं है या यदि आप अधिक जानकारी चाहते हैं।

अध्ययन का उद्देश्य क्या है?

अध्ययन का उद्देश्य प्रत्यक्ष साइनस लिफ्ट प्रक्रियाओं में पीजो सर्जरी और पारंपरिक रोटरी उपकरणों की तुलना करना है।

मुझे क्यों चुना गया है?

आपको चुना जाता है क्योंकि आप अध्ययन के मानदंडों को पूरा करते हैं।

क्या मुझे भाग लेना है

यह आपको तय करना है कि भाग लेना है या नहीं। यदि आप भाग लेने का निर्णय लेते हैं, तो आपको यह सूचना पत्रक रखने के लिए दिया जाएगा और सहमति प्रपत्र पर हस्ताक्षर करने के लिए कहा जाएगा। यदि आप भाग लेने का निर्णय लेते हैं, तब भी आप किसी भी समय और बिना कोई कारण बताए वापस लेने के लिए स्वतंत्र हैं।

यदि मैं भाग लेता हूँ तो मेरा क्या होगा?

जरूरत पड़ने पर फॉलो-अप के लिए आपको सर्जरी से पहले और बाद में कई बार आना होगा।

मुझे क्या करना होगा?

कुछ अन्य एहतियाती उपायों के साथ आहार सेवन में कुछ बदलाव किए जाएंगे और आपसे इसका पालन करने की अपेक्षा की जाएगी।

किस प्रक्रिया का परीक्षण किया जा रहा है?

प्रत्यक्ष साइनस लिफ्ट प्रक्रिया में पारंपरिक और पीजो इलेक्ट्रिक उपकरणों का उपयोग

अध्ययन के लिए क्या हस्तक्षेप है?

डायरेक्ट साइनस लिफ्ट प्रक्रिया पारंपरिक और पीजोइलेक्ट्रिक उपकरणों का उपयोग करके की

जाएगी, जिसके बाद ग्राफ्ट और प्रत्यारोपण लगाए जाएंगे।

भाग लेने के दुष्प्रभाव क्या हैं?

हालांकि प्रक्रिया के गंभीर दुष्प्रभावों की कोई रिपोर्ट नहीं है, लेकिन प्रतिभागियों को मतली और पोस्ट ऑपरेटिव उल्टी जैसी दवाओं के न्यूनतम दुष्प्रभाव हो सकते हैं। यदि प्रक्रिया के दौरा न कुछ भी होता है तो हमारे पास किसी भी आपात स्थिति को प्रबंधित करने के लिए कुशल कार्मिक और विशेष उपकरण हैं।

यदि प्रतिभागियों को ऑपरेशन के बाद कोई अन्य लक्षण दिखाई देते हैं, तो अभिभावक को तुरंत डॉक्टर से बात करनी चाहिए।

भाग लेने के संभावित नुकसान और जोखिम क्या हैं?

अध्ययन में भाग लेने के कोई नुकसान नहीं हैं, दवाओं के न्यूनतम दुष्प्रभाव हो सकते हैं।

भाग लेने के संभावित लाभ क्या हैं?

डायरेक्ट साइनस लिफ्ट प्रक्रिया से पोस्टीरियर एट्रोफिक मैक्सिला में इम्प्लांट लगाने में मदद मिलेगी जिससे कार्यात्मक दक्षता बढ़ेगी।

क्या होगा यदि नई जानकारी उपलब्ध हो जाती है?

कभी-कभी एक शोध परियोजना के दौरान, अध्ययन किए जा रहे शोध के बारे में नई जानकारी उपलब्ध हो जाती है। यदि ऐसा होता है, तो आपको इसके बारे में सूचित किया जाएगा और अध्ययन में होने वाले परिवर्तनों के बारे में सूचित किया जाएगा। आप अध्ययन के बीच में हटने के लिए स्वतंत्र हैं। यदि आप अध्ययन जारी रखने का निर्णय लेते हैं, तो आपसे एक अद्यतन सहमति फॉर्म पर हस्ताक्षर करने के लिए कहा जा सकता है।

जब शोध अध्ययन बंद हो जाता है तो क्या होता है?

यदि अध्ययन निर्धारित समय से पहले समाप्त / बंद हो जाता है, तो इसका कारण रोगियों को समझाया जाएगा।

अगर कुछ गलत हो जाए तो क्या होगा?

यदि कोई गंभीर प्रतिकूल घटना होती है, या अध्ययन के दौरान कुछ गलत हो जाता है, तो बीबीडीसीओडीएस ओपीडी में क्षेत्र में विशेषज्ञता रखने वाले डॉक्टरों द्वारा शिकायतों का निपटारा किया जाएगा।

क्या इस अध्ययन में मेरे भाग लेने को गोपनीय रखा जाएगा?

आपका नाम, पता या कोई व्यक्तिगत या अन्य जानकारी बीबीडीसीओडी के बाहर साझा नहीं की जाएगी।

शोध अध्ययन के परिणामों का क्या होगा?

शोध का आयोजन कौन कर रहा है?

यह शोध अध्ययन शैक्षणिक संस्थान (BBDCODS) द्वारा आयोजित किया जाता है।

क्या अध्ययन समाप्त होने के बाद अध्ययन के परिणाम उपलब्ध कराए जाएंगे?

यदि रोगी चाहे तो अध्ययन का परिणाम उसे उपलब्ध कराया जाएगा।

अध्ययन की समीक्षा किसने की है?

संस्थान के एचओडी/आईआरसी/आईईसी ने अध्ययन की समीक्षा की और उसे मंजूरी दी।

अधिक जानकारी के लिए संपर्क करें ।

डॉ. जया महातो

ओरल और मैक्सिलोफेशियल सर्जरी विभाग।

बाबू बनारसी कॉलेज ऑफ डेंटल साइंसेज।

लखनऊ-226028

भीड़: 7247852712

डॉ लक्ष्मी बाला,

संस्था की आचार समिति के सदस्य सचिव,

पता: बाबू बनारसी दास विश्वविद्यालय, फैजाबाद रोड, आतिफ विहार,

लखनऊ, यूपी । 226028

ईमेल: bbdcods.iec@gmail.com

पं. का नाम -

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ईमेल -

टेलीफोन नंबर। -

पीआई के हस्ताक्षर

नाम.....

तारीख.....

प्रतिभागी को सूचना पत्र की एक प्रति और हस्ताक्षरित सहमति प्रपत्र दिया जाएगा।
अध्ययन में भाग लेने के लिए धन्यवाद।

ANNEXURE –VII

DEPARTMENT OF ORAL AND MAXILLOFACIAL SURGERY, BBDCOHS CASE HISTORY

1. Patient Demographics

- Patient ID / Serial Number: _____
- Name: _____
- Age / Gender: _____

2. Chief Complaint:

3. History of Present Illness

4. Medical and Sinus History

- Systemic diseases: _____
- History of sinusitis (acute/chronic, frequency, medications taken)
- Smoking / Allergies / Nasal obstruction

5. Dental History

- Previous extractions: Tooth numbers _____
- Oral hygiene status
- History of prosthetic rehabilitation (Removable/Fixed)
- Periodontal status
- Parafunctional habits

6. Clinical Examination

- Maxillary Arch Form: ☐ U-Shaped ☐ V-Shaped ☐ Square
- Ridge Height and Width: (Visual + probing)
- Opposing Occlusion: ☐ Dentulous ☐ Edentulous ☐ Partially Edentulous
- Extraoral: Facial symmetry, Sinus tenderness (palpation), TMJ examination

7. Radiographic Evaluation (CBCT-Based)

- Residual Alveolar Bone Height (in mm): _____
- Residual Ridge Width (in mm): _____
- Bone Quality: ☐ D1 ☐ D2 ☐ D3 ☐ D4
- Sinus Membrane Thickness (in mm): _____
- Presence of Septae: ☐ Yes ☐ No
- Presence of Polyp / Mucosal Thickening: ☐ Yes ☐ No

- Sinus Pathology (if any): _____

8. Diagnosis

9. Surgical Plan

- Surgical Approach: ☐ Direct/Lateral window Sinus Lift
- Group Allocation: ☐ Rotary Instruments ☐ Piezoelectric Surgery
- Graft Material (if any) _____
- Membrane Used (if any): _____
- Implant Placement: ☐ Immediate ☐ Delayed

10. Intraoperative Details

- Date of Surgery: _____
- Operative Time: _____ minutes
- Visibility at Surgical Site: ☐ Excellent ☐ Moderate ☐ Good ☐ Poor
- Perforation of Schneiderian Membrane: ☐ Yes / ☐ No, Size: _____ mm
- Bleeding (Intraoperative): ☐ Minimal ☐ Moderate ☐ Excessive
- Additional Complications (if any): _____

11. Postoperative Evaluation Criteria

- A. Operative Time: _____
- B. Visibility (Surgeon Grading): ☐ Excellent ☐ Moderate ☐ Good ☐ Poor
- C. Membrane Perforation: ☐ Yes / ☐ No
- D. Swelling (3-point measurement):
 - External Eye → Angle of Mandible
 - Lateral Eye → Angle of Mandible
 - External Eye → Mental Protuberance
 - On 1st Hour, 2nd Day, 7th Day
- E. Pain Assessment (Wong-Baker Scale): 1st Hour, 1st Day, 7th Day

12. Follow-Up Notes

- Postoperative Healing: ☐ Uneventful ☐ Mild Infection

13. Final Outcome (if implant placed)

- Implant Stability Test (e.g., ISQ / torque)
- Complications (if any): _____
- Overall Patient Satisfaction: ☐ High ☐ Moderate ☐ Low

ANNEXURE –VIII

EVALUATION SHEET

Patient Name -

OPD No.-

Age/ Sex -

Contact no.-

1. OPERATION SITE VISIBILITY & OPERATION TIME

OPERATION TIME	VISIBILITY

2. INCIDENCE OF SINUS MEMBRANE PERFORATION:

3. SWELLING

EVALUATION DAYS	EXTERNAL EYE TO ANGLE OF MANDIBLE	EXTERNAL EYE TO ANGLE OF MANDIBLE	EXTERNAL EYE TO MENTAL PROTUBERANCE
Pre Operative			
2 nd Day			
7 th Day			

4. PAIN EVALUATION

EVALUATION DAY	WONG BAKERS PAIN ASSESSMENT SCORE
Pre-Operative	
1 st Hour	
1st Day	
7 th Day	

ANNEXURE –IX



TURNITIN

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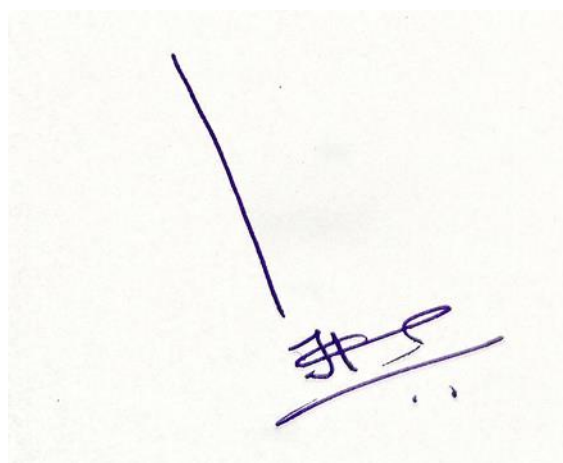
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