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Precision and Safety in Rhinoplasty: The Advancements and Challenges of the Piezoelectric Ultrasonic System

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Abstract **Case Report**

The introduction of the piezoelectric system in rhinoplasty, based on ultrasonic vibration with various tip shapes and sizes, has significantly enhanced surgical precision, safety, and protection of surrounding tissues. This innovative technique requires minimal pressure on the bone, even on mobile structures, thereby reducing the risk of unintended fractures. Wide exposure is necessary to optimize bone visualization, allowing for delicate rasping and contouring. The dorsal and lateral aesthetic lines can be sculpted with high accuracy using ultrasonic tips, preventing deformities and instability. However, the technique demands skilled and well-trained surgeons due to the fragility of the instrument, which is susceptible to breakage or malfunction.

Keywords: Piezoelectric system, Tissue protection, Bone contouring, and Minimal pressure.

INTRODUCTION

Rhinoplasty is one of the most complex and intricate procedures in facial plastic surgery, requiring a balance of aesthetic refinement and structural preservation. Traditional osteotomy techniques, while effective, often pose challenges such as uncontrolled fractures, excessive trauma to surrounding soft tissues, and post-operative irregularities. In recent years, the introduction of piezoelectric technology in rhinoplasty has revolutionized the field by offering a more precise, controlled, and minimally traumatic alternative for bone sculpting. Piezoelectric instruments, utilizing high-frequency ultrasonic vibrations, allow for selective bone cutting while preserving adjacent neurovascular structures and soft tissue integrity. This method reduces the risk of iatrogenic fractures, promotes better healing, and enhances surgical predictability, making it an increasingly preferred choice for both primary and revision rhinoplasty procedures. However, the technique requires extensive surgical exposure and skilled execution due to the fragility of the instrument and the learning curve associated with its use. This publication explores the application of piezoelectric technology in rhinoplasty through case studies demonstrating its efficacy in achieving aesthetic and functional improvements. By analyzing patient outcomes, surgical techniques, and challenges associated with this method, we aim to highlight the transformative impact of ultrasonic rhinoplasty on modern nasal surgery.

CASE STUDIES

CASE 1

A 34-year-old woman underwent ultrasonic structural open rhinoplasty. She presented with a broad nasal bridge, a dorsal hump, and an undefined, droopy nasal tip, which she described as giving her nose a masculine appearance (Figure 1). Following full exposure of the osseocartilaginous vault, a small bony cap was removed using a piezoelectric rasp tip, preserving the underlying perichondrium. The upper lateral nasal walls were contoured with the same instrument, while the cartilaginous hump was reduced by 2mm, maintaining the integrity of the ULC mucosa. The lateral nasal walls were sculpted using the piezo rasp to narrow the width and reduce nasal bone convexity. Bilateral complete osteotomies (medial oblique, transverse, and low-to-low) were performed with piezoelectric instrumentation. A cephalic trim, tip suturing, and a septal extension graft were employed to refine the nasal tip. The results, evaluated preoperatively

and nine months postoperatively, demonstrated significant improvement in nasal symmetry and aesthetics (Figure2). "All patients provided informed consent for the inclusion of their images/figures in this study, ensuring compliance with ethical guidelines."

Before:

Figure 1: Different perspectives of the nose before rhinoplasty in Case 1

After:

Figure 2: Different perspectives of the nose post-rhinoplasty with the piezoelectric system in Case 1

Case 2

A 23-year-old woman with severe facial asymmetry complained of a crooked, elongated nose with a dorsal hump and a drooping tip. She had no history of facial trauma or previous surgery but reported breathing difficulties due to significant S-shaped septal deviation, with cephalic convexity toward the left and caudal convexity toward the right (Figure 3). She underwent a closed low-strip asymmetric Let-Down preservation rhinoplasty. The septum was completely detached from the maxilla and the perpendicular plate of the ethmoid bone, then rotated and secured in the midline within a precisely sculpted groove in the premaxilla using a piezoelectric instrument. Complete osteotomies (transverse, radix, right low-to-low) and a left ostectomy were performed. The osteocartilaginous vault was shifted as a whole to the left and medialized. Fine-tuning of the sidewalls was achieved with piezoelectric sculpting. The tip deformity was corrected using cephalic trim, tip suturing, and a columellar strut (Figure 4). The patient's results, assessed preoperatively and ten months postoperatively, showed a marked improvement in nasal structure and symmetry.

Before:

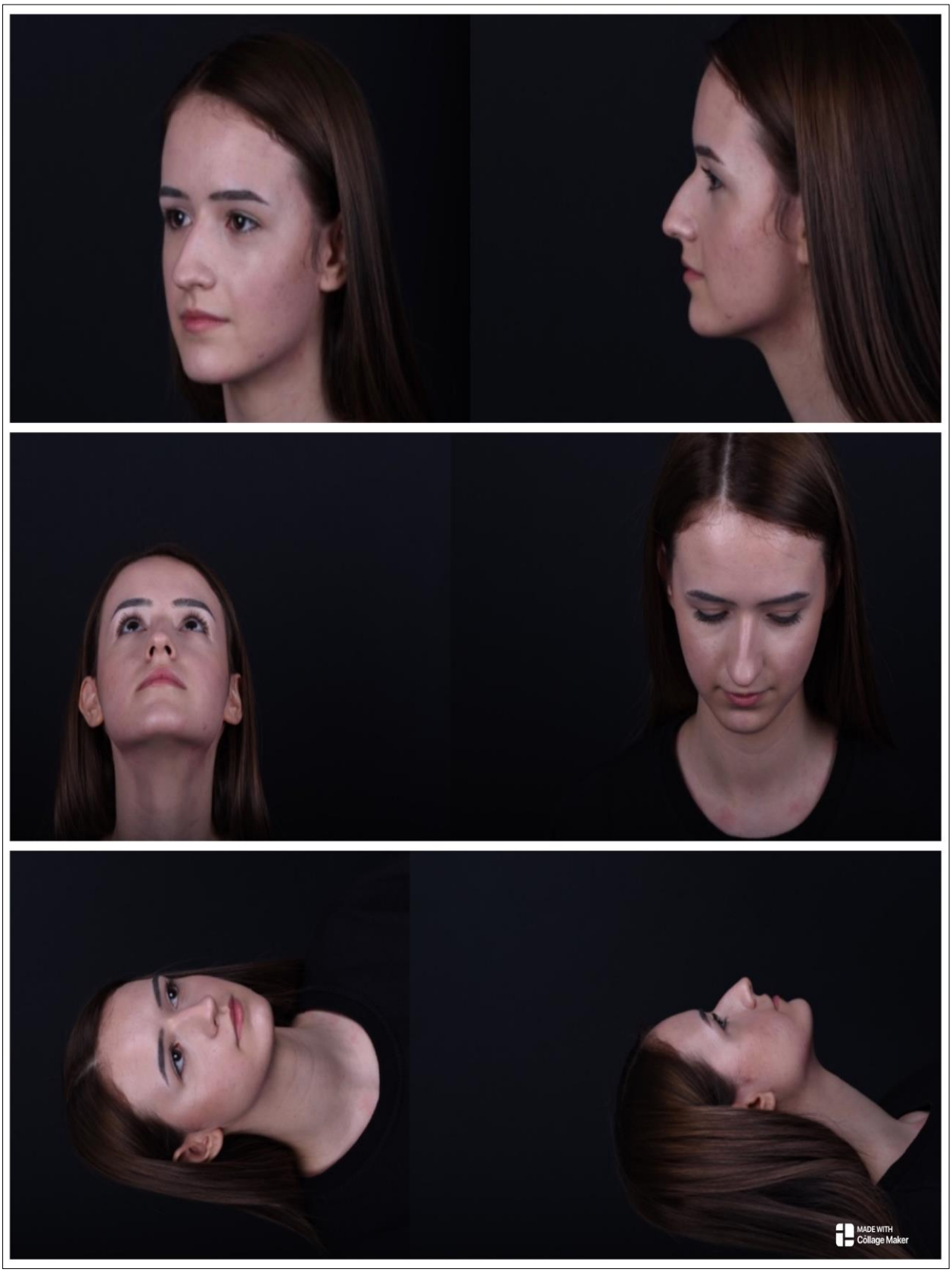

Figure 3: Different perspectives of the nose before rhinoplasty in Case 2

After:

Figure 4: Different perspectives of the nose post-rhinoplasty with the piezoelectric system in Case 2

DISCUSSION

The introduction of the piezoelectric system to the world of rhinoplasty has had a significant impact, greatly improving outcome precision, safety, and post-operative healing [1]. This innovative technique is based on high-frequency ultrasonic vibrations transmitted through the tip of the instrument, allowing for precise bone cutting while preserving surrounding neurovascular structures and soft tissue [2]. It also minimizes damage to osteocytes, promoting optimal healing of bony cells during bone harvesting [7]. Additionally, the risk of uncontrolled fractures is drastically reduced, ensuring

stability even during mobilization and bone reshaping [1-3]. Osteoplasty performed with the piezoelectric device requires extensive exposure, from the keystone area to the radix longitudinally, and the release of the pyriform ligament [1]. This exposure allows for the visualization of deformities and the removal of the bony cap without creating an unwanted open roof [4], or contour irregularities, which are more common with older osteotomy techniques. This approach also permits the use of short, angulated saws for improved rhinosculpture [8-11], and safe bone contouring to achieve a narrower and more symmetrical nasal dorsum [11]. The various tiny and differently shaped piezo tips allow for precise rasping, even on mobile bones, and enable gentle pressure application on angulated bone areas [5]. In the newly adapted technique, lateral osteotomy is performed first, followed by another lateral osteotomy, and then the optional medial oblique osteotomy [1]. Osteoplasty via rasping provides sufficient aesthetic narrowing of the dorsum, particularly in the convex lateral portion of a crooked nose. Rasping along the cephalic border of the medial oblique dorsum refines the K area while transitioning from the bony to the cartilaginous vault and narrows the width of the nasal pyramid [8-10]. The new device allows for delicate and highly precise lateral osteotomy close to the maxillary bone within the nasolabial groove, preventing visible and palpable step deformities. Although this method is slower than older techniques, it is significantly safer [6-9]. The lowering of dorsal aesthetic lines can be freely modified by sculpting the bone without excessive pressure. To prevent post-operative re-deviation, the piezo drill tip can be used to create a precise hole within the nasal spine, allowing for better septal fixation with sutures [11]. For enhanced stability of a deviated caudal septum, the "swinging door" technique involves dissecting the cartilage along the maxillary crest and flipping it over the nasal spine to achieve a straighter position [12]. Like any advanced technology, the ultrasonic device used in rhinoplasty is not without its flaws; it can break or fail. This is a more sophisticated technique that requires skilled and well-trained surgeons to master. Additionally, it is more expensive compared to other technologies. Due to the extensive exposure required, including skin elevation and ligament release, patients may experience increased post-operative edema, bruising, and external scars compared to conventional techniques [13].

CONCLUSION

Piezoelectric surgery has introduced a groundbreaking advancement in rhinoplasty, offering unparalleled precision, improved safety, and aesthetically superior outcomes. While the technique presents challenges, including cost, technical complexity, and potential for increased postoperative swelling, its benefits outweigh these limitations. By minimizing soft tissue damage, reducing the risk of uncontrolled fractures, and enhancing contour refinement, the piezoelectric system provides a safer and more effective alternative to conventional osteotomy methods. With proper training and expertise, this ultrasonic technology allows surgeons to achieve more natural, harmonious nasal results.

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