Objective: To evaluate power-assisted bone removal in cosmetic rhinoplasty.

Design: Nonrandomized, nonblinded, retrospective evaluation of consecutive case series.

Setting: Academic facial plastic surgery practice.

Interventions: Power-assisted bone removal in 105 consecutive rhinoplasties requiring nasal bone reduction.

Main Outcome Measures: Subjective evaluation by patient and surgeon.

Results: Of the 105 patients undergoing power-assisted bone removal, 102 obtained satisfactory refinement of the nasal dorsum after 1 operation. Three patients required surgical revision of the nasal dorsum following power-assisted bony hump reduction. Of these, 2 required surgical revision for delayed bone regrowth, while the remaining patient required surgical treatment of a persistent bony hump. Ultimately, all 105 patients achieved satisfactory surgical results. No other surgical complications were observed.

Conclusions: Power-assisted bone removal is a useful adjunct for bone removal in cosmetic rhinoplasty. This study confirms the previously reported advantages of powered instrumentation for patients with small bony humps or modest bony asymmetries. Moreover, because powered instrumentation is comparativelyatraumatic, it may be preferable for use in nasal bones previously weakened by trauma, aging, or prior nasal surgery. Finally, because the powered nasal rasp permits rounding of the bone edges, the characteristic widening associated with flat hump reduction is reduced, and the need for aggressive sidewall infracture is diminished. Complications associated with power-assisted bone removal were rare.
the elderly patient.\textsuperscript{2,3} Ironically, even when osteotomies are performed correctly, mobilization of the nasal bones may predispose to skeletal misalignment during the healing process and taint the otherwise satisfactory surgical result.

One popular alternative to use of the traditional osteotome for bone reduction is the carbide-tip nasal rasp. While modest contour deformities can be eliminated with the carbide rasp, the physical forces and broad movements produced by manual rasping may significantly weaken the osseocartilaginous vault. Although avulsion of the upper lateral cartilage is often cited as the most serious potential complication of manual rasping, it may also increase trauma to the soft tissue envelope or result in traumatic bone regeneration.\textsuperscript{1,4} Manual rasps have also been faulted for their inability to selectively remove focal bone defects without unwanted reduction of the surrounding bone.\textsuperscript{1,5}

The goal of contemporary rhinoplasty remains controlled modification of the skeletal contour with minimal disruption of the nasal vault. Since an attractive and natural-appearing nasal dorsum usually requires very little bone reduction, and since overzealous bone removal may lead to unwanted sequelae, precise bone removal is fundamental to successful hump reduction. Although traditional blunt-force osteotomy techniques remain an indispensable tool in cosmetic rhinoplasty, power-assisted instrumentation now offers a useful alternative for controlled resection of the bony hump. In addition to precise bone removal, power-assisted instrumentation also permits 3-dimensional sculpting without the soft tissue trauma characteristic of manual rasping.

Although long-term clinical results of power-assisted instrumentation are not yet available, the initial published reports have been favorable. In a clinical review of 30 patients undergoing nasal hump reduction, Becker and coworkers\textsuperscript{5} reported successful profile realignment using a shielded cutting burr for nasal bone removal. In addition to successful hump reduction, the authors reported no surgical complications and cited reduced trauma to the overlying soft tissues, smoother bone contour, and more precise bone reduction as advantages of powered instrumentation over the traditional nasal rasp. The authors also concluded that power-assisted bone removal was most helpful in cases where limited bone reduction was necessary, such as with small bony humps. Although Guyuron\textsuperscript{6} first reported successful use of the shielded cutting burr for deepening of the nasofrontal angle in the late 1980s, the large number of newly marketed devices for power-assisted nasal bone removal attests to the resurgence of this technology. Various designs of guarded cutting burrs and reciprocating power rasps, with and without suction and/or irrigation, are now commercially available for use in cosmetic rhinoplasty.

This retrospective patient series examines 105 consecutive rhinoplasty cases in which the osseous vault was reduced using power-assisted instrumentation. In addition to confirming the previously reported advantages of enhanced precision and reduced soft tissue trauma, this study identifies new applications of power-assisted hump removal. The advantages and complications of power-assisted hump removal are also discussed.

### METHODS

Included in this retrospective chart review were 209 consecutive rhinoplasty cases performed by the senior author (R.E.D.). Of these, 137 patients were female, and 72 were male (age range, 14-76 years). Sixty patients in this series had a history of rhinoplasty, and the remaining 149 underwent primary procedures. Of the 209 consecutive rhinoplasty cases, 104 required no bone reduction and so were excluded from the study. Of the 105 patients undergoing bone reduction, 92 underwent dorsal hump reduction using a power-assisted rasp for bone removal. The remaining 13 patients underwent power-assisted bone removal for leveling of the nasal dorsum prior to dorsal implant or graft placement. Follow-up ranged from 3 to 36 months.

Nasal hump reduction was considered successful if both the patient and surgeon deemed the surgical improvement satisfactory. Patient satisfaction was assessed using comments made during follow-up visits and/or requests for surgical revision. Surgeon satisfaction was based on determination of acceptable refinement of the dorsal profile and the brow-tip aesthetic lines.

In nearly all cases, the external rhinoplasty approach was used for surgical exposure. To avoid inadvertent rasping of the nasal cartilage, the cartilaginous hump was first removed with sharp dissection prior to bone reduction. Similarly, the overlying periosteum was painstakingly elevated to minimize periosteal inflammation during bone removal. Following adequate exposure, bone removal was performed under direct visualization using the Micro-100 reciprocating rasp (Hall Surgical, Largo, Fla) (Figure 1). The subcutaneous pocket was then liberally irrigated with saline to expel bone dust or tissue fragments. If the width of the bony vault was deemed excessive, lateral osteotomies were performed to provide additional narrowing of the bony pyramid. In most cases, satisfactory sidewall narrowing was accomplished using the “incomplete” or “greenstick” lateral osteotomy technique.

Of the 105 patients undergoing power-assisted bone removal, all but 3 achieved initial satisfactory refinement of the bony nasal contour. Although no serious complications were observed in this study, 4 patients developed delayed swelling over the nasal bones and required monthly serial injections of triamcinolone acetone (5-10 mg/mL) to control bone regrowth. While steroid treatment eliminated the swelling in 2 patients, 2 other patients failed to comply with monthly steroid injections and ultimately required revision surgery for removal of regenerated bone. One final patient also underwent revision surgery for treatment of inadequate reduction.
hump reduction. Ultimately, all 3 revision cases achieved satisfactory outcomes.

CASE 1

A young woman presented with nasal obstruction and a crooked nose. Examination revealed a mildly overprojected and boxy tip, dorsal asymmetry, and a small dorsal hump (Figure 2A). Anterior rhinoscopy revealed nasal valve collapse and deviation of the caudal septum. Treatment included conservative reduction of the dorsal septum and sculpting of the bony hump using the reciprocating power rasp. Despite hump reduction, no lateral osteotomies were performed. Septoplasty, bilateral spreader grafts, and tip-plasty completed the surgical procedure. Postoperatively, the patient has improved dorsal symmetry, smooth, uninterrupted brow-tip aesthetic lines, and precise profile realignment (Figure 2B).

CASE 2

A young woman presented with nasal airway obstruction seeking concomitant aesthetic refinement. Examination revealed a deviated septum, a small dorsal hump, and a broad ptotic nasal tip (Figure 3A). Following septoplasty, the cartilaginous dorsum was lowered by approximately 1 mm. The bony rhinion was then reduced with the power rasp leaving a rounded bony contour. Incomplete lateral osteotomies were performed to gently narrow the bony nasal vault. Nasal tip-plasty completed the surgical procedure. Postoperatively, the patient has improved nasal harmony with precise realignment of the small nasal hump (Figure 3B).

CASE 3

A young woman presented seeking cosmetic rhinoplasty. Examination revealed a narrow middle vault, a
broad, slightly underprojected tip, and a small dorsal hump (Figure 4A). With the external approach, the dorsal septum was trimmed conservatively, and the bony dorsum was lowered with the power rasp. Small onlay grafts of septal cartilage were placed over both upper lateral cartilages, and tip-plasty completed the surgical procedure. No lateral osteotomies were performed. Postoperatively, the patient has smooth, uninterrupted brow-tip aesthetic lines and precise realignment of the small nasal hump (Figure 4B).

CASE 4

A young man presented with airway obstruction 1 week after closed fracture reduction was performed elsewhere. In addition to airway restoration, the patient also sought hump reduction. Anterior rhinoscopy revealed airway impingement from a traumatic displacement of the nasal septum. External examination revealed mild bone displacement and a prominent nasal hump deformity (Figure 5A). Two weeks following injury, an external approach was used to trim the dorsal septum and reduce the bony dorsum with the power rasp. Greenstick lateral osteotomies were used to narrow the bony vault. Nasal tip-plasty and septoplasty completed the surgical procedure. Postoperatively, the patient has improved profile alignment and preserved nasal symmetry despite recent displaced fracture of the bony pyramid (Figure 5B).

CASE 5

A middle-aged woman presented seeking profile enhancement and treatment of posttraumatic nasal airway obstruction of 3 months’ duration. Examination revealed a nasal hump deformity, nasal valve collapse, and septal deviation (Figure 6A). Surgical treatment began with septal repositioning and reduction of the cartilaginous dorsum. After placement of bilateral spreader grafts,
the bony dorsum was sculpted with the power rasp. Lateral osteotomies were not performed. Postoperatively, the patient has improved profile harmony and smooth brow-tip aesthetic lines (Figure 6B). Despite the patient’s age and history of recent nasal trauma, hump reduction was accomplished effectively without blunt-force osteotomies.

CASE 6

A young woman presented with nasal airway obstruction and a crooked nose (Figure 7A). Examination revealed an S-shaped dorsal deformity with deviation of the nasal bones to the right side. Nasal valve collapse and a caudal septal deflection were also present. Surgical treatment included septoplasty and inferior turbinatectomy. The nasal bones were managed with a single left medial osteotomy and outfracture coupled with rasping of the right nasal bone. Left-sided spreader grafts and tip-plasty completed the procedure. Despite a conspicuous bony asymmetry, nasal straightening was accomplished without the need for destabilizing lateral osteotomies (Figure 7B).

CASE 7

An elderly man presented with worsening nasal obstruction and associated sleep disturbance. The patient reported a lifelong nasal deformity resulting from untreated childhood nasal trauma. Examination revealed a twisted nasal vault and deviated septum (Figure 8A). Nasoseptal reconstruction was recommended. Surgical treatment included power rasping of the protruding left nasal bone, a right medial osteotomy with outfracture, and spreader graft placement. Postoperatively, the nose appears straight without the use of multiple blunt-force osteotomies in this elderly patient (Figure 8B).
Creating the perfect nasal contour through hump reduction remains a formidable challenge. Arguably, the most difficult aspect of hump reduction is the flawless execution of blunt-force osteotomies. In addition to creating a smooth and attractive nasal profile, osteotomies must also produce brow-tip aesthetic lines that are slender and straight, with perfect bilateral symmetry. Optimal siting of the intended bone cuts, carefully controlled movement of the osteotome, and preservation of skeletal stability are all essential elements for a properly executed hump reduction.

Numerous factors contribute to the difficulty of blunt-force osteotomies. In addition to being a “blind” procedure where bone cuts are hidden beneath the skin–soft tissue envelope, blunt-force osteotomies are also complicated by the physical inconsistencies of human bone. Individual variations in nasal anatomy, as well as acquired bony imperfections, make precise control of the osteotome challenging, particularly for the novice surgeon. Moreover, because brittle or previously damaged nasal bones may behave unpredictably when subjected to blunt-force impacts, even the experienced surgeon is likely to encounter the occasional osteotomy-related complication. Indeed, the pervasive number of bony contour deformities in patients seeking revision rhinoplasty serves to underscore the risks of blunt-force osteotomies.

Few would argue that properly executed osteotomies require precise control of the osteotome. However, exacting movement of the osteotome along a predetermined path is often disrupted by areas of dense bone, which may divert the osteotome away from the desired cut and toward a plane of lesser resistance. Perhaps the most common example of osteotome deflection occurs during dorsal hump resection when the Rubin osteotome is diverted deep to the dense outer cortex, resulting in overresection of the bony hump. Acquired imperfections in bone strength, such as those stemming from nasal trauma or prior osteotomies, may also complicate bony hump resection.

Even when the dorsal hump resection is executed to perfection, additional osteotomies are then required to infracture the nasal sidewall and eliminate the open roof deformity. Because aggressive release and medialization of the nasal bones is a destabilizing maneuver, lateral osteotomies may predispose to crooked, asymmetric, pinched, or collapsed nasal bones, especially when multiple (eg, medial or intermediate) osteotomies are performed. Moreover, complications are more likely in patients with attenuated bone strength, where the application of blunt-force energy may fracture, detach, or even shatter weakened nasal bones. Such patients include those with previous nasal fractures, prior surgical osteotomies, or pathologic thinning of the nasal bones from aging, osteoporosis, or long-term steroid use. Indeed, many rhinoplasty surgeons regard advanced age or a recent nasal fracture as an absolute contraindication to blunt-force osteotomies.

While a sharpened osteotome in expert hands usually results in a satisfactory outcome, creating the perfect dorsal contour with traditional osteotomies may elude even the seasoned rhinoplasty surgeon, particularly in patients with preexisting bone deformities. Because osteotomies are performed blindly, considerable repetition is necessary to gain adequate tactile skills and become adept at proper execution. Although severe complications of nasal osteotomies are uncommon, contour deformities of the nasal bone remain a common source of dissatisfaction among patients undergoing rhinoplasty.

Because high-impact bone cuts are poorly suited to delicate, precise bone reduction, power-assisted instrumentation has become an attractive alternative to traditional bone removal. In contrast to the Rubin osteotome, which may leave an irregular or uneven bony surface after dorsal hump resection, the power-driven rasp is ideally suited to incremental “planing” of the bone surface. The resulting bone reduction is precise, smooth, and uniform. When compared with manual rasping, power-
Indications for Power-Assisted Nasal Bone Removal

1. Small (bony) hump deformities (cases 1, 2, and 3)
2. Shallow nasofrontal angle
3. Thin or brittle nasal bones (cases 5 and 7)
4. Unstable nasal bones (recent fracture or osteotomy) (cases 4 and 5)
5. Narrow nasal vault with dorsal hump (cases 3, 5, and 6)
6. Modes bony asymmetry (cases 1, 6, and 7)
7. Bone smoothing prior to dorsal augmentation

Driven bone removal also results in a smoother surface as observed under a scanning electron microscope. The capacity to remove bone in a precise and controlled fashion is particularly advantageous in patients requiring only slight or modest hump removal where a conventional osteotome may fail to uniformly split the outer cortex (cases 1, 2, and 3).

Another advantage of the power rasp is the capacity to sculpt the nasal bones in 3 dimensions. Unlike the Rubin osteotome, which produces only a flat, squared bone cut, the reciprocating rasp permits rounding of the bone edges to approximate the slender, rounded contour of the dorsal crest. Although the profile alignment is equivalent, the sculpted nasal bones appear slimmer with less widening of the brow-tip aesthetic lines. As a consequence, the need for aggressive sidewall infracture is often eliminated, and acceptable narrowing can usually be accomplished with less destabilizing greenstick osteotomies. Because the extent of nasal bone mobilization is thereby reduced, the likelihood of severe osteotomy complications such as detachment, asymmetry, pinching, comminution or airway obstruction is also reduced, particularly in high-risk patients.

One possible drawback of this approach to hump reduction is the potential for pathologic thinning of the nasal bones. However, while nasal bone sculpting may potentially weaken the bony vault, we have observed no adverse effects of bone sculpting, probably because the thinning is confined to a small segment of the dorsal bone margin near the caudal border. Moreover, the potential risk of thin bone edges must be weighed against the benefit of preserving skeletal stability by avoiding aggressive nasal infracture.

Although most patients undergoing bone sculpting will still require lateral osteotomies for adequate sidewall narrowing, in the occasional patient with extremely narrow nasal bones, sculpting may obviate lateral osteotomies altogether because the open roof is avoided entirely (case 5). Similarly, sculpting may be advantageous in patients with modest asymmetries of the bony vault because asymmetric rasping of crooked nasal bones may permit straightening of the brow-tip aesthetic lines without the need for multiple destabilizing osteotomies (cases 1, 6, and 7). Hence, for these select patients, the risks of blunt-force osteotomies may be avoided completely because all necessary bone alterations can be performed with the power rasp.

Another advantage of the power rasp is the absence of high-impact forces associated with blunt-force osteotomies or manual rasping. Occasionally, when high-impact forces are brought to bear on weak or unstable bones, unwanted destabilization may ensue. Hence, many surgeons forgo hump reduction in a recently fractured nose to avoid the risk of further bone injury. However, in the absence of traumatic comminution, the power rasp seems to permit immediate bony hump reduction with minimal risk of bone disruption (cases 4 and 5). In the same way, patients with weak or brittle bones, including elderly or osteoporotic patients, may also undergo hump reduction with less likelihood of comminution or excessive destabilization of the bony pyramid (cases 5 and 7). Thus, the relative absence of high-impact forces associated with powered instrumentation seems to reduce bone-related complications during hump reduction in patients with weak or unstable nasal bones.

Finally, the focal and precise nature of the power rasp is also a distinct advantage over the Rubin osteotome or manual rasp. Like Becker and coworkers, we observed very little soft tissue trauma associated with powered instrumentation. Moreover, the power rasp permitted rapid bone debulking and facilitated small focal bone reductions. Hence, the power rasp provides a precise and delicate alternative to the osteotome or manual rasp for bony hump reduction.

Based on the findings of this study, we have identified several patient groups in which power-assisted bone removal may be preferable to traditional blunt-force osteotomies (Table). Two groups, those with a shallow nasofrontal angle and those with modest bony humps, have been reported by Guyuron and Becker et al., respectively. The results of the present study confirm the advantages reported by these authors. The remaining patient groups, including those with osteoporotic nasal bones, recently fractured nasal bones, extremely narrow nasal bones, mildly asymmetric nasal bones, or patients requiring dorsal augmentation, represent newly identified indications for which powered instrumentation may be preferable to traditional rhinoplasty techniques.

In this patient series, 102 patients safely underwent nasal hump reduction with power-assisted instrumentation in a single operation. Furthermore, none of the classic sequelae of blunt-force osteotomies were observed in this series. However, one possible drawback of this technology is the tendency to produce a slightly wider-appearing nasal dorsum. While several patients in this series experienced increases in dorsal width, particularly when lateral osteotomies were not performed (cases 1, 3, 5, and 6), the observed increases were either desirable or within acceptable aesthetic limits. Moreover, the use of powered instrumentation does not preclude the use of lateral osteotomies if nasal width is deemed excessive. Finally, as with any destabilizing maneuver in rhinoplasty, the benefits of additional narrowing must be balanced against the potential for complications that result from bony infracture. Since many of the patients described herein were at increased risk for complications of high-impact osteotomies, we believe that a modest increase in dorsal width is an acceptable trade-off for a safe and predictable outcome.

Although complications of the power rasp were rare, 4 patients developed progressive postoperative swelling.
confined to the area of bone rasping. Two of these patients were successfully managed with monthly injections of triamcinolone acetonide (5-10 mg/mL) into the overlying soft tissues. The remaining 2 patients were non-compliant with the steroid regimen and ultimately required revision surgery to eliminate bone regrowth. We postulate that callus formation produced by heat-induced bone injury led to new bone formation. However, callus formation is not uncommon following other forms of bone injury, including that produced by traditional osteotomies or conventional rasping, and it usually resolves promptly with low-dose steroid injections. Moreover, the problem was observed only in a small subset of the total study population, which suggests that the risk of callus formation is comparatively low. Nevertheless, the formation of a surgically induced callus is bothersome because it requires serial steroid injections, which may lead to dermal thinning or telangiectasias. Further study is needed to define the risk of callus formation and to optimize prevention and treatment.

In conclusion, while use of the reciprocating power rasp will never fully supplant the traditional blunt-force osteotomy, the power rasp does seem to be a valuable adjunct in aesthetic rhinoplasty. In addition to enhanced precision over the Rubin osteotome, the power rasp is less traumatic, making it more suitable for use in brittle nasal bones, posttraumatic bony deformities, or revision cases. Since the power rasp permits rounding of the nasal bridge, the extent of sidewall infracture can be reduced, thereby preserving skeletal stability. In rare cases, patients with extremely narrow bony vaults may undergo hump resection without the need for lateral osteotomies, further minimizing the risks of hump reduction. Complications of powered instrumentation are rare, and soft tissue trauma is minimal.

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REFERENCES

Quotable
Rhinoplasty is an easy operation. It is only hard to get good results.

Aufricht