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Osteoplasty in Crooked Nose Deformity: A Novel Approach

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Abstract
Background Crooked nose deformity is one of the most difficult issues to correct by rhinoplasty, as it can result in undesired late sequelae. Revision rates are often high, and numerous operational techniques have been tested. This study describes a crooked nose rhinoplasty technique that reduces the need for a double osteotomy in the long nasal bone.
Methods This study included 26 patients with an I-shaped crooked nose deformity. In the surgical correction of the crooked nose deformity, previously defined techniques were applied to the cartilage identically. However, the traditional double osteotomy of the long nasal bone was not performed. Instead, the bone protruding laterally from the long nasal bone was narrowed by rasping with a file or burr, and this section was delivered to the maxilla accordingly. Angle values were measured preoperatively and postoperatively. Two lines were used to measure the angle: The first was drawn from the midpoint of the glabella to the midpoint of the upper lip, while the second, representing the nasal dorsal axis, consisted of both the osseous and cartilaginous parts from the nasion to the anterior nasal spine. The angle between these two lines was taken as the angle of deviation from the median line.
Results Postoperatively, patients' angle values were significantly smaller than preoperatively. After 1 year, no persistence was observed.
Conclusion In crooked nose deformity surgery, the osteoplasty technique applied to the lateral protrusion of the long nasal bone described here was as successful as a double osteotomy. Thus, certain complications of a double osteotomy can be avoided. In addition, as no greenstick fractures were induced, the long-term persistence risk was also reduced.
Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Crooked nose · Rasping · Osteoplasty · Twisted nose · Rhinoplasty

Introduction

Crooked nose deformity is defined as a deviation of the nasal pyramid from the midline to any degree in any direction. Three types are differentiated: I-shaped, C-shaped, and S-shaped. The I shape refers to a linear deviation to one side. In the C shape, a concavity is found on one the side and a convexity on the other. In the S shape, there is more than one convexity and more than one concavity.

Causes of crooked nose deformity can be traumatic, iatrogenic, or congenital. A deviation of the septum caused by any of these reasons pulls the entire nasal pyramid in the direction of the deviation. This deformity is one of the most difficult issues for rhinoplastic correction; it can lead to long-term disappointment due to late sequelae with a significant revision rate. Therefore, numerous techniques have been tried at every stage. The fundamental aim is to obtain

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a straight nose in the long term by aligning the nasal septum, the superior lateral cartilage, and the nasal bones to the midline. This outcome requires a detailed preoperative analysis to examine the three-dimensional anatomy of the nose. In crooked noses, deformities in the lower two-thirds affect cartilaginous and soft tissues. To correct these sections, techniques including cartilage resection, narrowing, scoring, corrective sutures, and grafts are applied [1]. For corrections in the upper third, however, various osteotomy techniques have been described. To achieve long-term positive results for median alignment in the lower two-thirds, support by median alignment of the upper one-third using osteotomy is needed.

In a typical crooked nose deformity, the nasal bone ipsilateral to the deviation is shorter, and the contralateral nasal bone is longer, displaying a flatter course. Bilateral lateral osteotomy is often sufficient for a surgical alignment of the nose to the midline. However, there is a long-term trend for the nose to return to the previous position. In addition, every lateral osteotomy involves risks of complications such as nasal obstruction, esthetic rocker deformity, long-term edema, or ecchymosis [2]. Aggressive osteotomy can lead to a laceration of the periosteum and soft tissue damage [3]. Some surgeons, therefore, recommend the use of a narrower osteotomy, but in that case, too, there is a risk of the broken bone returning to its previous position. Thus, finding techniques that reduce the necessity of an osteotomy are desirable.

This study presents the results of a new osteoplasty technique for the long nasal bone that reduces the number of osteotomies.

Materials and Methods

The study was started with approval from the ethics committee of our hospital. A thorough medical record review was conducted for each patient to identify preoperative complaints, surgical techniques, surgical complications, and clinical follow-up. In all cases, a written informed consent form comprehensively explaining possible side effects of the surgery and defining the postoperative period was given to and signed by the patients.

This study, which was carried out between February 2015 and January 2016, included 26 patients showing osseous and cartilaginous roof deviations with I-shaped crooked nose deformities. Patients were excluded if they had an S- or C-shaped crooked deformity, had undergone previous nasal surgery, or were simultaneously receiving other surgical interventions (such as endoscopic sinus surgery). Patients were recorded and followed; photographs from five different angles (frontal, helicopter, lateral, and basal views) were taken before surgery and monthly after surgery for 1 year.

Surgical Technique

After preparing the surgical field and covering the patient, the facial midline in the vertical plane was established, marking the middle of the glabella, philtrum, and mentum. Subsequently, lines x and y (designated as bilateral lateral osteotomy lines) and line z (located at the end of the long nasal bone in the nasofacial area) were marked. The space between lines y and z on the long nasal bone was marked in line with the frontal process of the maxilla (Fig. 1).

For sufficient vision, the open technique of rhinoplasty was applied to the patients. After achieving sufficient hemostasis by injecting 1/100,000 epinephrine, a mid-columellar incision was made. Following elevation of the osseous and cartilaginous roof applying the component method, first the cartilaginous hump was resected and then, using a rasp, the osseous hump was removed. Subsequently, a septoplasty was made, leaving at least 15 mm caudal and dorsal septal cartilage intact. When the caudal septum deviated from the nasal spine, it was dislocated and placed on the midline of the nasal spine. Then, an incision was made on the side of the long nasal bone directly above the inferior concha, and the periosteum above the frontal processes of the maxilla was elevated. We performed a tunnel with an elevator but did not deglove the whole nasal bony pyramid (Fig. 2). With a rasp, the over expanded frontal processes of the maxilla between lines y and z were abraded and reduced to the same level as the other side (Fig. 3). This segment is weakened, not abraded, to the

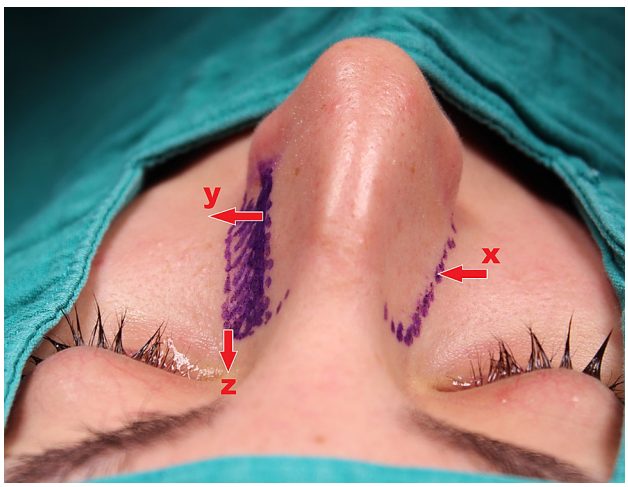

Fig. 1 Preoperative view, lines *x* and *y* designated lateral osteotomy lines; *z* edge of the long nasal bone in the nasofacial area; *shaded area* between *y* and *z* expanded frontal processes of the maxilla (area to be removed)

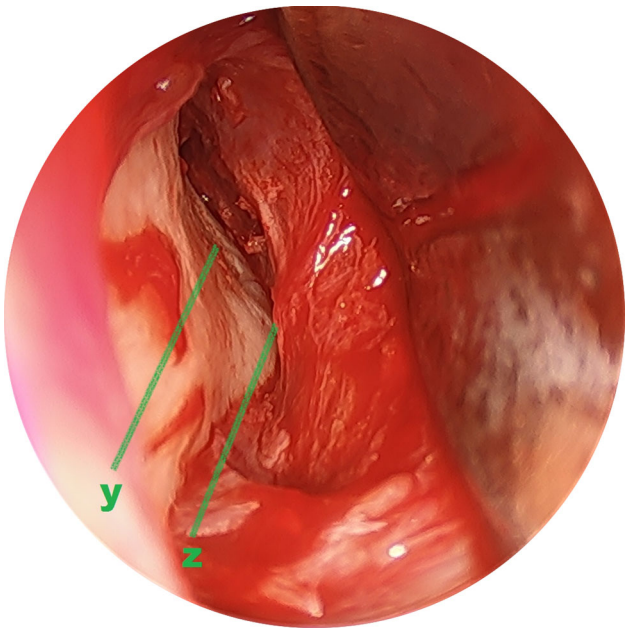

Fig. 2 Intraoperative photograph of left nasal bone before rasping

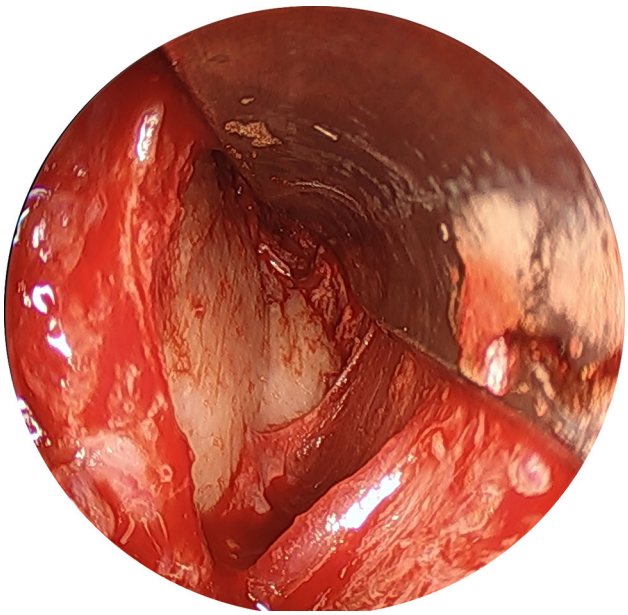

Fig. 3 Intraoperative photograph of left nasal bone after rasping

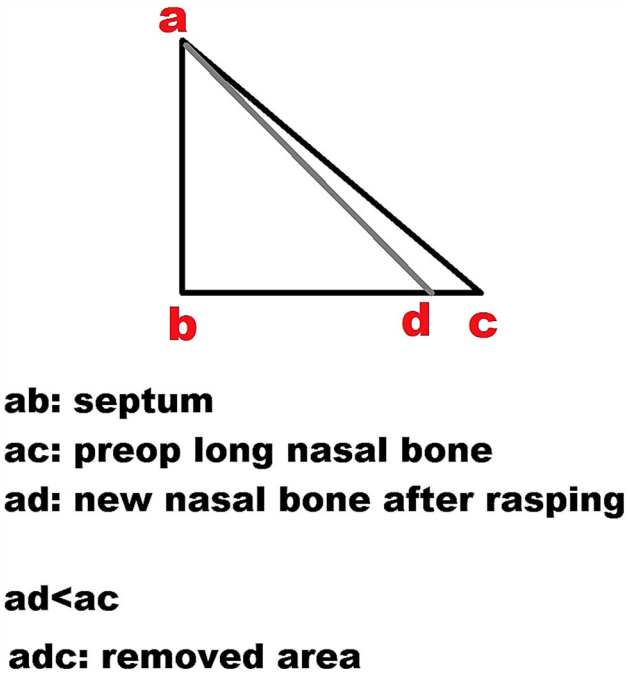

Fig. 4 Long nasal bone is narrowed primarily and was shortened at the same time without resection

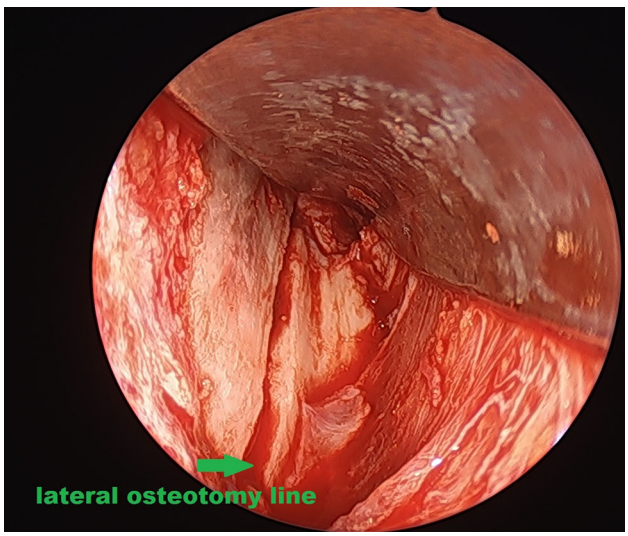

Fig. 5 Intraoperative photograph of left nasal bone after osteotomy. The inner mucoperichondrium was preserved to avoid nasal bone collapse

perichondrium. Thus, while the bone was narrowed primarily, it was also simultaneously shortened without requiring a resection (Fig. 4). This procedure was done with a rasp. Afterward, lateral and medial oblique osteotomies were carried out on the long nasal bone along line y (Fig. 5). An out-fracture was made with a Freer elevator, reaching complete release of the nasal bone. Lateral and medial osteotomies of the short nasal bone were performed along line x, resulting in an in-fracture. Through the in-fracture, the deviated septum was oriented along the midline. On the contralateral side of the deviation, a spreader graft was put into place. With this spreader graft, the long nasal bone on the contralateral side of the deviation was lateralized (out-fracture). In some cases, where the dorsal septal cartilage did not reach the medial line, a small spreader graft was needed on the short side of the nose, where the in-fracture had been made (Fig. 6).

Fig. 6 Postoperative view of the patient in Fig. 1 after rasping of the *shaded area* and osteotomies

Finally, a tip plasty was made. The operation was completed by placing an intranasal silicon tampon and an external thermal splint. The intranasal silicon tampons were removed on day four postoperatively; the external splint on day seven postoperatively. Figure 7 provides schematic views of the surgical technique.

Image Analysis

Measurement of the angle of nasal deviation was made with pre- and postoperative (anterior) frontal photographs, using Adobe Photoshop CS6 software package. Two lines were used to measure the angle: The first line was drawn from the midpoint of the glabella to the midpoint of the upper lip (L1), while the second line represented the nasal dorsal axis, consisting of both the osseous and the cartilaginous parts from the nasion to the anterior nasal spine (L2). The angle between these two lines was taken as the angle of deviation from the median line (Fig. 8).

The aim of the surgery was to achieve an angle of or close to 0°. In the literature, success rates are divided into four scaled categories by comparing pre- and postoperative deviation from the ideal position [4]. The ideal degrees of correction are calculated (ideal degrees of correction = ideal angle−crooked nose angle). The ideal angle value is 0°. The postoperative nasal angle, if any, is measured and compared with the ideal degree of correction according to the calculation described above. The percentage of the postoperative angle in relation to the ideal correction degree is used to divide the results into categories of success. Ratios of 90–100% are "excellent," and ratios of 70–89%, 50–69%, or less than 50% are classed as "good," "acceptable," and "unsuccessful," respectively (Table 1).

Statistical analysis was carried out using Statistical Package for the Social Sciences version 22.0 for Windows (SPSS Inc., Chicago, IL, USA). Preoperative and postoperative angle values were compared by paired t test to assess the surgical improvement. A result of $p < 0.05$ was considered significant.

Results

This study was carried out with 26 patients (18 women and 8 men) receiving rhinoplasty because of an I-shaped crooked nose deformity. Patients' mean age was 24.8 years (range 18–34). Patients were followed postoperatively for an average of 11.7 months (range 8.14 months).

Patients' mean deviation angle value preoperatively was 8.7 ± 2.7° (range 4.1–15). The mean value postoperatively was 0.45 ± 0.7° (range 0–2.1). Postoperative angle values were significantly smaller than preoperative values ($p < 0.001$). In 18 patients, the postoperative angle value achieved the ideal angle of 0° (Table 2).

The distribution of surgical success rates is shown in Table 3. According to this distribution, surgical success was "excellent" in 20 patients, "good" in five patients, and "acceptable" in one patient (Table 3).

No complications were encountered during the process in any patient. Preoperative and postoperative views of sample cases are shown in Fig. 9a, b.

Discussion

Crooked nose surgery classically includes humpectomy, upper lateral cartilage separation, septum correction, and osteotomies of the nasal bones using an open surgery technique [5]. This study also utilized an open surgery technique in all cases. As this deformity is often accompanied by septum deviation, septoplasty plays a key role in the operation. The surgical steps have been listed by Rohrich et al. [6] as follows: exposure of all deviated structures through an open rhinoplasty approach; release of all septal mucoperichondrial attachments; straightening of the septum; buttressing of septal support with cartilage grafts; reduction or correction of turbinate deformities as necessary to allow for correction of the deviated septum; and precise nasal osteotomies. For each of these steps, numerous different techniques have been tried.

The most commonly used intervention in the cartilaginous section uses spreader grafts. In this operation, spreader grafts are placed on the concave side to keep the

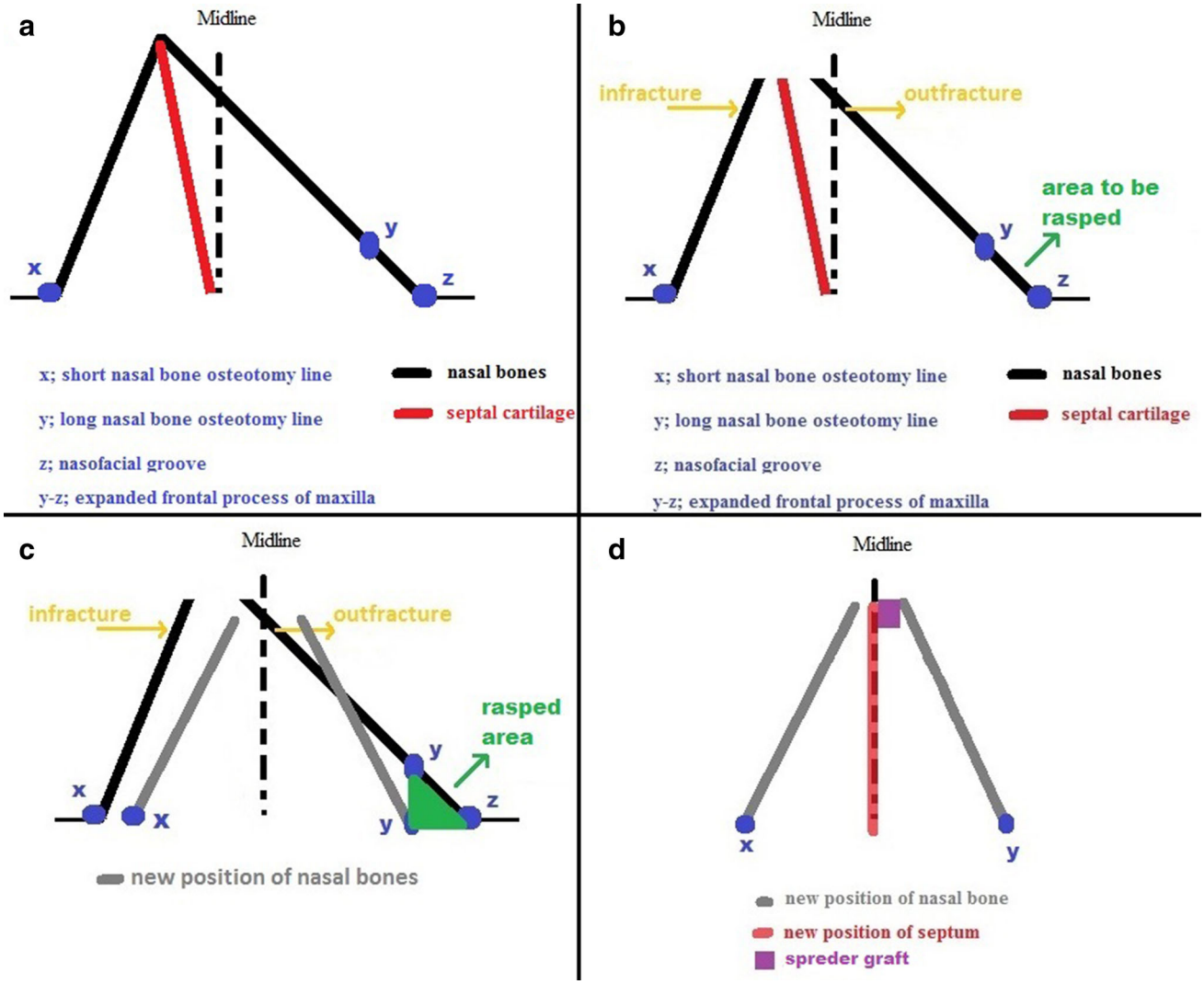

Fig. 7 Schematic view of the surgical technique from the alar base (**a** preoperative view, **b** after hump removal, **c** after rasping of *shaded area* and osteotomies, **d** final view after insertion of spreader graft)

septum in the midline. In the linear deviations seen in the cases of this study, the graft needs to be inserted into the contralateral side of the deviation. This graft is required for esthetic reasons as well as to restore respiration. In selected cases, spreader grafts can be inserted bilaterally [7]. However, the bilateral use of spreader grafts may thicken the nasal dorsum in an undesirable fashion. The use of spreader grafts is important for long-term results. Another technique applied to the cartilaginous structure is the septal crossbar graft described by Boccieri and Pascali [8]. This study used spreader grafts in all patients.

In crooked nose surgery, osteotomies play an important role. In the presence of a dorsal hump, a recognized technique consists of asymmetric dorsal hump resection before osteotomy. Other techniques include asymmetric osteotomy, double osteotomy, oblique osteotomy, and lateral osteotomy [9]. The aim of the osteotomy is to obtain a mobile bone segment that allows the bone pyramid to be aligned to the anatomical midline. Thus, an osteotomy can be performed with an external or internal perforator or a continuous technique. However, in mobilizing nasal bones completely, extreme care must be taken. Inadequately performed osteotomies can cause greenstick fractures that can lead to a recurrence of the deformity due to tissue memory. Thus, it is crucial to perform complete osteotomies, not greenstick fractures. Greenstick fractures may result in a shift of the bony pyramid during the postoperative period.

Any osteotomy applied during rhinoplasty carries the risk of complications. These risks include bleeding, ecchymosis, hematoma, mucosa laceration, adhesions, over-narrowing and collapse, irregularities, callous

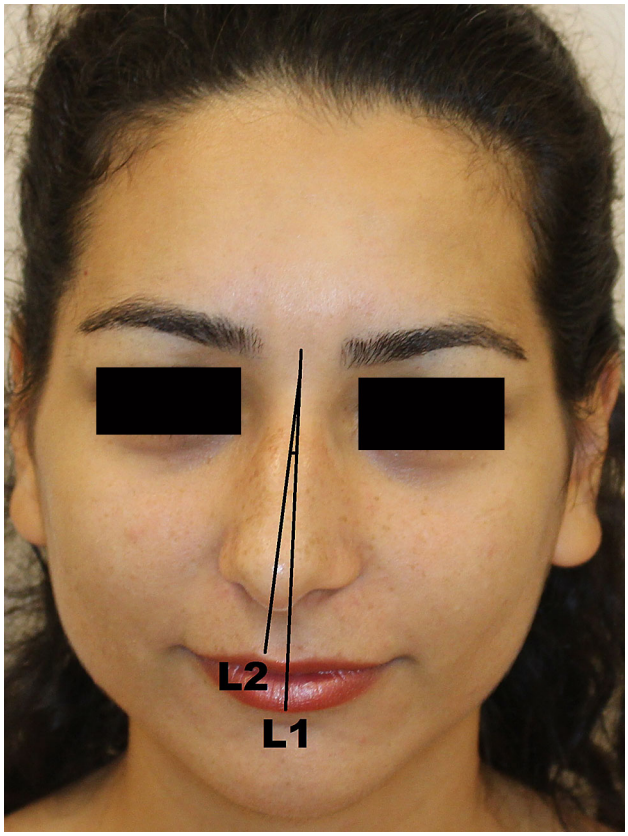

Fig. 8 Method for measuring the angle of deviation (*L1* from the midpoint of the glabella to the midpoint of the *upper lip*; *L2* nasal dorsal axis consisting of both osseous and cartilaginous parts from the nasion to the anterior nasal spine)

Table 1 Surgical results according to comparison with ideal angle values

Success rate	Correction (%)
Excellent	90–100
Good	70–89
Acceptable	50–69
Unsuccessful	<50

Table 2 Patients' preoperative and postoperative angle values

	Preoperative angle values (mean ± SD)	Postoperative angle values (mean ± SD)	Statistics paired *t* test
Patients ($n = 26$)	8.7 ± 2.7	0.45 ± 0.7	($p < 0.001$)

Table 3 Surgical success rates

	Excellent (90–100%)	Good (70–89%)	Acceptable (50–69%)	Unsuccessful (<50%)
Patients ($n = 26$)	20	5	1	–

formation, open roof deformity, or staircase phenomenon [10]. Therefore, alternative methods to an osteotomy are desirable. Limited external deviations are treated with unilateral osteotomies. It has been asserted that unilateral osteotomies achieve more controlled results and prevent the complications involved in bilateral osteotomy [9]. As an alternative or in addition to osteotomies, camouflage grafts are also used. Previously, dorsal onlay grafts were used for this purpose [11]. Septal cartilage, the cephalic portion of the lower lateral cartilage, and the temporalis fascia have been used as camouflage grafts [12]. The osteoplasty technique applied to crooked noses in this study avoided at least one osteotomy and, thus, diminished patients' risk of complications.

The aim of the osteotomy in crooked nose deformity is to lengthen the short side of the nasal bone and shorten the long side. If that aim cannot be achieved by asymmetrical nasal hump resection, additional osteotomies are necessary. The bone area between lines y and z (shown in the figures in the materials and methods section) may require the greatest care during osteotomy. If this section is not broken adequately and delivered to the maxilla, the crooked nose deformity may persist. The most commonly performed intervention in this area is double osteotomy. However, intermediate osteotomies carried out in this region that is covered with fine skin may cause irregularities such as staircase phenomenon. In the osteoplasty technique applied in this study, this section was thinned by a burr or a rasp and delivered to the face. Thus, irregularities were avoided. As no greenstick fractures occurred, the long-term persistence risk was also reduced. None of the study's patients displayed irregularities in the lateral nasal wall or staircase phenomenon. Patients were followed for approximately 1 year after surgery; no cases of persistence occurred, demonstrating the technique's success as an alternative to the double osteotomy method.

Admittedly, the methodology for determining dorsal angulation could be stronger. This study's limitations could be addressed by utilizing three-dimensional analysis now available.

Fig. 9 **a** and **b** Preoperative and postoperative views of sample cases

Fig. 9 continued

Conclusion

Bone pyramid interventions are key to the long-term success of crooked nose deformity corrections. Intermediate osteotomies performed on the side of the long nasal bone can lead to irregularities and staircase phenomenon in this region. The osteoplasty technique used in this study reduces the need for double osteotomies and avoids concomitant complications. This osteoplasty technique is an effective technique in crooked nose deformity surgery.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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