Bony Cartilaginous Graft in Unilateral Cleft Lip Rhinoplasty

Chuong Dinh Nguyen, MD,* Tho Thi-Kieu Nguyen, MD, PhD,†‡ Son Thiet Tran, MD, PhD,§ Annette S. McDevitt, PhD,‖ and John M. Hodges, MD, FACS.§

Background: Cleft rhinoplasty is a challenging form of nasal correction of both aesthetic and functional deformities. The septal cartilage in many Asian patients are not sufficient and weak. Does a combination of the septal cartilage and the bony septum have both aesthetic and functional benefits to secondary unilateral cleft rhinoplasty?

Patients and Methods: Thirty patients with a unilateral cleft lip palate underwent open rhinoplasty from October 2018 to January 2021. After preserving a 10 mm L-strut, the posterior cartilaginous and bony septum were harvested as an integrative unit. The osteocartilaginous graft was used as a causal septal extension graft and an extended spreader graft. Correcting the asymmetry of the tip and tip projection followed. The intraoperative harvested composite graft was analyzed. Acoustic rhinometry and the 3-dimensional anthropometric measurements of the external nose were assessed before and after surgery.

Results: The osteocartilaginous unit was much larger than the cartilaginous part of this unit. The mean nasal tip height and the nasolabial angle increased significantly after surgery. The measurement of cross-sectional areas and volumes by acoustic rhinometry revealed that septorrhinoplasty provided a significant increase in the function of both nasal cavities.

Conclusions: This septal bony cartilaginous graft is effective for cleft lip nasal deformity when correcting the deviated septum, creating a supporting frame to correct the nasal tip asymmetry, improving function.

Key Words: bony cartilaginous graft, secondary cleft rhinoplasty, unilateral cleft lip nasal deformity

(J Craniofac Surg 2022;33: 2513–2521)
subperiosteally over the entire septum, downward to the ante-
rior nasal spine, and upward to the junction between the upper
lateral cartilages (ULCs) and septum. The correct plane was
found by using the No. 15 blade to incise the perichondrium at
the anterior border and allow access. The strong fibrous at-
tachments at the junction of the septum and maxillary crest
need to be carefully released. The dissection was continued past
the bony cartilaginous junction to gain access to any posterior
bony deflection or spur. The ULCs were dissected from the
dorsal margin of the septum with a straight sharp scissor
without damaging the mucosa and K-area. The endoscopic
0 degrees can be used.

The septal cartilage was incised using a No. 15 scalpel blade,
leaving at least 10-mm L-strut crural and dorsal strut cartilage
to support the lower nose. C-curve chondrotomy was made in
the transition of the dorsal to the caudal L-strut septum. The
subdorsal cartilaginous incision was continued on the perpen-
dicular plate of the ethmoid bone (PPE) by using Cottle or
Jansen septum scissors to prevent fracture of the keystone area.
At the level of the intercanthal line, the ethmoid bone posterior
to the junction was cut in a ∼60 degrees downward tilt with an
angled scissor (Water scissor) to avoid injury to the overlying
skull base. Great care was taken not to rock or twist the bone
during cutting to prevent possible damage to the cribiform plate.
Next, PPE and vomer were incised posteriorly and in-
feriorly. The 5 mm osteotome was used to break the attachment
to the maxilla. The front half of the inferior border of the graft
was composed of cartilage and bone was cut using the same
osteotome. The back half was excised using a curved osteotome,
so it met the osteotomy line coming down from above while
including the vomer. Finally, the posterior part of the graft was
fractured by shaking gently with septal platform forceps.
Grasping the bony part of the graft with multtooth forceps
prevented fracture of the connecting portion between the septal
cartilage and PPE. The bowing mid-portion of the cartilaginous
septum and the deviated portions of the vomer and PPE were
not separated before it was moved anteriorly as one integrated
unit (Fig. 1). At last, we separated the septal mucoperitoneum
from L-strut on the non-CS.

This bony cartilaginous graft (BCG) was used as a caudal
septal extension graft (SEG) on the CS and an extended
spreader graft on the other side. The side-to-side fixation of the
SEG was used for correction of the asymmetry of the
caudal septal border is deviated to the non-CS. The bony part
of the composite graft was affixed to the existing caudal sep-
tum and used as an internal splint to straighten the septum,
after making several holes on the hard bone for secure at-
tachment. The cartilaginous part was placed between the
medial crura of the LLCs. A spreader graft was placed
on the opposite side to straighten the curvature of the dorsal
nasal septum, splint the SEG, and improve the internal
nasal valve. Once the SEG and extended spreader graft were
in their final position, the ULCs were resutured to the septum
to prevent inferomedial collapse. The septal mucosal flaps
were sutured to the septum and the structural grafts. The SEG
and the caudal septum were repositioned in the midline
(Fig. 2).

After attaching the LLCs to the SEG to maintain symmetry,
lateral crural strut grafts and shield tip grafts were used addi-
tionally as indicated in each case for projection and symmetry.
No patient underwent turbinectomy or turbinoplasty.

Study Parameter
To obtain accurate data on size and shape, the septum
was digitally scanned, and the information was analyzed using
ImageJ software (National Institutes of Health, WA). Multiple
markers were digitally placed to plot the anatomical boundaries
of the nasal septum and the program was used to calculate the
complete dimensions of the harvestable septum. The intra-
operative sizes of the osteocartilaginous unit (including the
quadrangular septal cartilage, the sphenoidal process, vomer,
and PPE) and the cartilaginous part of this unit (the quad-
angular cartilage and the sphenoidal process) were measured.

To assess and objectify the nasal airway obstruction, nasal
cross-sectional areas (CSAs) and volumes were determined by
using an Eccovision Acoustic Rhinometer (HOOD Lab-
oratories, MA). Measurements were repeated in each nasal cavity
before and 10 minutes after topical application of 5 drops of a
nasal vasoconstrictor (0.1% xylometazoline hydrochloride) into
each nostril to eliminate the functional effect of the nasal mu-
cosa. CSAs were measured on the rhinogram: CSA1 corre-
sponded to the nasal valve area; CSA2 corresponded to the
anterior portion of the inferior turbinate; and, CSA3 corre-
sponded to the posterior portion of the inferior turbinate. Pre-
operative and postoperative values were assessed for the
functional benefit of removal bowing septal cartilage and de-
viated posterior bony septum as well as the efficacy of structural
grafts.

To assess tip rhinoplasty results after the septum surgery,
including tip projection, rotation, and overall volume change,
we used a 3-dimensional (D) photographic method. Photo-
graphs were made using the Romexis Viewer 5.1.1.R software.
The 3D imaging data were acquired using a Planmeca Promax
3D Proface system (Helsinki, Finland) under standard con-
ditions. Serial 3D face photos were acquired with a system,
preoperatively and postoperatively for analyses of the nasal
deformity by an independent professional imaging technologist.
Anthropometric landmarks and linear distance measurements
were identified based on Farkas et al4, Dixon and Toriumi.5 The
nasal base height was measured by selecting 2 points: the sub-
nasale and the pronasale. The nasal tip projection was measured
by the distance between the alar sulcus and the nasal tip.
Goode’s ratio was the proportion between the nasal tip pro-
jection and the distance from the nasion to the pronasale. After
aligning the preoperative image and the postoperative image,
we measured the overall volume changes with a volume histo-
gram (Fig. 3). The preoperative measurements were compared
with the last postoperative measurements.

To follow-up, the first visit was taken 3 to 4 weeks post-
operatively. Subsequent visits were taken at 3 months, or later
postoperatively. Each visit, 3D photos and acoustic rhinometer
were performed.

Statistical Analysis
A paired-sample t test was used to compare the related sample
(CS versus non-CS) and follow-up results. The descriptive
statistic was mean ± standard error of the mean. A P value <0.05
was considered statistically significant.

RESULTS

Number of Patients
In our study, 30 patients (13 males and 17 females) with
UCLP underwent secondary rhinoplasty. The mean age was
23.4 years. Follow-up duration averaged 175.6 days (ranged
from 3 to 13 mo).
Intraoperative Measurement of Harvestable Osteocartilaginous Unit

Thirty septal specimens were analyzed. The mean length of the cartilaginous part was 29.1 ± 7.8 mm, and the mean width was 18.5 ± 3.9 mm. The mean length and width of the osteocartilaginous unit were 38.3 ± 6.9 and 22.3 ± 3.5 mm, respectively.

Acoustic Rhinometry Results

Results observed before and after primary septorhinoplasty in the 30 individuals with repaired UCLP are shown in Supplemental Table 1 (Supplemental Digital Content 1, http://links.lww.com/SCS/E143). In all patients, the septum was harvested, and SEG was used to enlarge the nasal valve.

Before surgery and nasal decongestion, there were significant differences in mean CSA1, CSA2, CSA3, and volume values between the CS and non-CS (P < 0.001). Similar results were observed in CSA1 and volume values after nasal decongestion.

On the CS, before and after nasal decongestants, the mean CSA1, CSA2, CSA3, and volumes values increased significantly after surgery (P < 0.05). Mean CSA3 markedly increased, where the position is the posterior part of the inferior turbinate—this corresponds to the posterior bony part of the septum with more deviation on the CS. No significant differences were noted in mean CSAs and nasal volumes after surgery between the CS and the non-CS.

On the non-CS, before and after nasal decongestion, the mean CSA2, CSA3, and nasal volumes markedly increased after surgery.

Three-Dimensional Measurement Outcomes

Tip projection and rotation were typically deficient in the cleft nose, especially on the CS, on preoperative images.

After surgery, the nasal base height increased significantly (from 17.09 ± 1.59 to 18.34 ± 1.64 mm, P < 0.05). The nasal tip projection markedly increased (from 18.35 ± 2.24 to 20.36 ± 2.09 mm, P < 0.001). Regarding the mean Goode’s ratio, there was a significant improvement of the tip height (from 0.49 to 0.52, P = 0.005).

DISCUSSION

Secondary cleft lip nasal deformity is defined as those distortions that persist despite primary operative maneuvers including residual or iatrogenic deformities.

Nowadays, many children will have undergone a primary nasal correction at the time of unilateral cleft labial repair; including: centralizing the anterocaudal septum; elevating the medial crus of LLC; releasing the lateral crus; medializing and securing the alar base; repositioning LLC with interdomal and intercartilaginous sutures; and correcting any vestibular web.³ Primary nasal correction at the time of cleft labial repair provides a cartilaginous foundation that minimizes subsequent deformity but does not obviate the likely need for “revisions.”⁵ However, there are also a number of patients who present in adolescence with an untouched nasal deformity. In cumulative American Board of Plastic Surgery tracer data through 2020, 21% of patients had primary nasal correction carried out at the time of cleft lip repair.⁶ Regarding the secondary cleft rhinoplasty patients included in this study, previous primary cleft rhinoplasties were not performed or not clearly documented.

Secondary cleft rhinoplasty is a challenging form of nasal correction. Cleft rhinoplasty uses the combination of many methods with standard esthetic techniques and meets the demand of a particular patient to improve both functional and esthetic outcomes. Open approach rhinoplasty allows the surgeon to address the CLND, nasal airway obstruction, and symmetry of the nose, and commonly incorporates cartilage grafts.

Nasal airway obstruction is present in over 60% of patients with CLND due to septal deviation, maxillary bony spurs, turbinate hypertrophy, vestibular webbing, and valve collapse.⁵ It is recommended to avoid septal resection and straightening.

FIGURE 1. (A) Sagittal section through of the nasal septum and the area where the bony cartilaginous graft was harvested (*dark blue area). (B and C) Various intraoperative harvestable composite grafts. C indicates cartilaginous septum; PPE, perpendicular plate of the ethmoid bone; SP, sphenoidal process; V, vomer.
FIGURE 2. Intraoperative graft harvesting and graft design. (A) Wide dissection for harvesting grafts. (B) Oblique view of graft design. (C and D) Side-to-side fixation of SEG and spreader graft on the opposite side. (E and F) Fixation of medial crura to caudal SEG in tongue-in-groove fashion. SEG indicates septal extension graft.
during childhood or early adolescence, noting these maneuvers should be reserved in cases closer to skeletal maturity. The nasal septum in the unilateral cleft lip nose is deviated caudally to the non-CS and is bowed posteriorly to the CS. The nasal septum posterior to the mid-point between the anterior and posterior nasal spine is comprised of 96% bone and deviated into the cleft airway in 80% of patients with UCLP. This area of maximum stenosis in the posterior airway was within 1.5 cm from the posterior nasal spine, an area that would not be corrected with a standard cartilaginous septoplasty. Friel and colleagues recommended that surgeons use a bony septoplasty in UCLP patients who have reached skeletal maturity. Jiang and colleagues also demonstrated that the maximal septal deviation often occurred at the inferior turbinate level. They suggested patients with CLP should undergo submucous resection and septoplasty often occurred at the inferior turbinate level. They suggested patients with CLP should undergo submucous resection of the cartilaginous and bony septum, including the vomer and the PPE as far as possible reaching the sphenoid sinus anterior wall.

Our results of acoustic rhinometry confirm that the differences between the non-CS and the CS result from nasal structural abnormalities due to the UCLP deformities. After septorhinoplasty, the mean CSAs and volume values on the CS increased significantly and there was no significant difference between the CS and non-CS, showing that the changes observed were indeed induced by the structural changes made by surgery. Without turbinectomy or turbinoplasty, the mean nasal volumes on both sides increased after septorhinoplasty. From a physiological standpoint, this surgery corrects the typical nasal deformities usually observed in these cases: downward displacement of the alar base on the CS; external and internal nasal valve collapse on the CS; and, posterior septum deviating toward the CS. Moreover, vomer deviation was significantly associated with anterior nasal airway stenosis, suggesting that bony septum can affect airway patency.

While bony septoplasty is used for correcting septal deviation and airway stenosis in patients with UCLP deformity, cartilaginous septoplasty is performed for cosmetic and reconstructive purposes to provide structural support such as columnellar strut or SEG. Septal cartilage can be used for several rhinoplasty procedures, and the measurements vary according to the repair of the deformity, but Asians have smaller quadrangle cartilage and cannot be used. The amount of ideally needed graft is greater than what the harvested Asian cartilage can provide. Simultaneously, it is best to maintain at least 10 mm width of dorsal and caudal septal segments, or L-strut, to preserve the tip and dorsal nasal support. The highest area of stress is on the inner angle near the transition of the dorsal to caudal septum. After maintaining the L-strut, there is a restricted amount of this valuable support without causing dorsal instability, according to Kim et al, the intraoperative mean caudal and dorsal length of the harvested septal cartilage were 15.1 and 18.2 mm, respectively.

In our clinical findings, after preserving at least a 10 mm L-strut, the mean intraoperative length and width of the osteocartilaginous unit (38.3 and 22.3 mm, respectively) were significantly longer than the cartilaginous part (29.1 and 18.5 mm, respectively). It was noted that the septal tail was usually more irregular and thinner than other parts of the septum. Kim et al conducted a morphological and histological evaluation and found that the sphenoidal process of patients with a deviated septum was more prominent and visible through the osseous line that links the PPE and vomer. The bony cartilaginous unit is an excellent material for adequate SEG for rhinoplasty, and its osseous part is also strong enough to enhance nasal tip support, tip stability, and tip projection. The SEG is not only an effective method for the correction of a short nose but also a very reliable graft for long-term support of the tip position. Brandstetter et al and Caughlin et al have shown that the long-term result does not depend on the individual technique of graft fixation: the side-to-side fixation, end-to-end fixation with unilateral splinting (perpendicular plate or thinned ethmoid bone), end-to-end fixation with extended spreader grafts, and with polydioxanone absorbable plates. The nasolabial angle reduced 2.2 degrees from the position 2 weeks postoperative, attributed to postoperative swelling, without changes in the dorsum and nasal length or tip projection after long-term follow-up.

For esthetic outcomes of secondary cleft rhinoplasty, the aims are to improve the nasal profile and nasal form on the frontal profile view. Key maneuvers include centralizing the anterocaudal septum; providing structural support and/or spreader graft for nasal airway; chondromucosal advancement of the LLC with interdoral and intercartilaginous sutures, lateral crural strut; and/oralar base repositioning. To obtain an optimal outcome, SEG is the best graft caudally. The greatest advantages of this composite graft are...
the ability to provide the rigidity and firmness of bone and the ease of use of cartilage simultaneously. SEG may cause postoperative rigidity of the nasal tip, but does provide sufficient quantity, length, or firmness of nasal tip support for counteacting the compressive force of the nasal skin envelope. In the present work, the cartilaginous part of BCG was placed between the medial crura of the LLCs in tongue-in-groove technique and the bony part was used as an internal splint to straighten of L-strut. Thus, the nasal tip was softened and had less rigidity. In some cases, the surgeon may need bone not only for use as an internal splint but also for straightening the external nose and the septum. The bony part of the septum is very strong to provide support, especially in centralizing the anterocaudal septum in CLND. These bones are also not absorbed due to the submucosal and subperiosteal dissection. Fixation of bone grafts to the L-strut can be facilitated by drilling several holes, allowing a secured fixation of the bone graft. These holes allow rapid ingrowth of vascularized tissue.
Ingrowth of tissue within and around the graft can stabilize the nasal tip in its surgical position without collapsing. The thin and flattened PPE grafts in the literature are employed to enhance caudal septum stability. Through these efforts, an optimal nasal tip rotation and projection via the efficient use of minimal septal cartilage was achieved. Our results show the improvement of tip projection as well as tip rotation. The mean tip height and the nasolabial angle were increased significantly.

The tip of the nose was rotated up as evidenced by 2D and 3D volumetric measurements (Figs. 4–7). By using the SEG, the surgeon can use this autograft in precise positions that preserve the qualities of each part, enabling stabilization at the base of the nose, providing excellent support to the nasal tip, and lengthening the nose.

In addition to the SEG on the CS, we used a spreader graft on the other side to secure the L-strut and create stronger cartilage support to stabilize the nasal base. Sutures through the ULCs, septum and structural grafts are placed to apply for support in the opposite direction of the L-strut deviation, thus correcting it and creating symmetry. The flaps serve as soft tissue braces across SEG at the bone-cartilage junction. Holt pointed out that the perichondrial layer of the septal lining flap has been shown to account for the majority of the flap’s biomechanical strength. This technique helps to maintain the symmetry of the lower two third of the nose (Fig. 6). In the present study, no patient experienced obvious reversion to the preoperative shape during the follow-up period.

Besides, the bony part of the septum is also not absorbed over a short time period. Membranous bone from the facial area maintains its volume to a significantly greater extent than the endochondral bone when autografted because of its thicker cortical plates and relatively thin spongy cancellous layer. Kayabasoglu et al demonstrated that bone grafts retained 90% of their lengths in 66% of patients, one third of patients showed resorption > 20% of their lengths. They concluded that bone grafts in nasal surgeries are reliable grafts and could be used as an alternative to cartilage grafts. An et al demonstrated that clear reversion and nasal deformation were never observed in short nose correction when combining the septal cartilage with PPE. Furthermore, the actual level of tip projection loss itself was very small according to the results of the postoperative follow-up of > 6 months. These results are assumed to be caused by the fact that the thick skin and soft tissue envelope of Asians’ nasal tip contribute to the stronger nasal cartilaginous framework more than simply a covering, and this has been an important component of the nasal tip structure, even after extensive

FIGURE 5. Left: Preoperative photographs of a male patient with unilateral cleft lip with or without palate. Right: One year after surgery.

FIGURE 6. Left: Preoperative photographs of a male patient with unilateral cleft lip with or without palate. Right: One year after surgery.
and advancement of chondromucosal not positioned at the time of cleft labial repair, and especially eral crus of the LLC to the piriform rim. If the medial crus was likely caused by inferior displacement and attachment of the lat-
normal anatomical position. The residual deformity of the LLC is cartilage reposition could be appropriate.3

medial footplate.3 Thus, the medial and middle crura should be in usually, some effort is made to lengthen the columella and lift the projection on the CS.28 In modern unilateral cleft labial repair, cartilage of the non-CS, resulting in alar
the medial crus is shorter and the lateral crus is longer than the total length of LLC on the CS is usually equal to the non-CS,
typically displaced inferiorly, laterally, and posteriorly. Although when the adequate and symmetrical projection of the nasal tip could not be obtained by repositioning of the cleft LLC using mucochondrial flap, an onlay cartilage graft may be used to augment the cleft LLC. The lateral crural strut grafts could also add support for the lateral wall, especially in cases with recurvatum of LLC and caudally displace of lateral crus of LLC. Thus, structural grafting could stabilize the nasal base and could be a preferred method for stabilization of medialized crura to unify the nasal tip and help to control final tip pro-
duction and tip symmetry. Moreover, we believe that alar re-
positioning is a powerful way to alter the geometry and volume of the nasal tip (Figs. 5, 7).

We also found no complication (saddle-nose deformation or cerebrospinal fluid leakage), due to unseparated septal mucoper-
tonem from the L-strut on the non-CS while harvesting the graft and using the sharp, angled septal bone scissors to cut the superior junction of the ethmoid bone.

The follow-up duration in our study is a relative limitation. Therefore, continued long-term follow-up would allow greater insight into the structural changes in outcomes. Moreover, sec-
ondary cleft rhinoplasty is challenging and associated with several malformations. The nasal structure sits on an asymmetric base, the septum is deviated, the ala on the CS is distorted and dis-
placed. Excellent esthetic and functional final results are based on the surgeon’s clinical skills of diagnosis and application of surgical skills to correct these severe deformities found in the CLND.

CONCLUSIONS

The BCG of the unilateral cleft nose takes advantage of bone cartilage when correcting the deviated septum to brace and support the L-strut. This effectively creates a supporting frame to stretch the tip of the nose, increases projection, and creates a firm axis to correct the lower nasal cartilage asymmetry as well as nasal asymmetry. Moreover, our study shows that septo-
rhinoplasty as described improves the function of the cleft nose.

ACKNOWLEDGMENTS

The authors acknowledge the medical staff of Gia Đình’s People Hospital for their contributions to the development of this project. Special thanks to Hung Viet Le, MD, Loc Tan Huynh, MD. The authors also thank scientific advisors: Associate Professor Truong Minh Tran, MD, PhD, at Cho Ray Hospital and University of Medicine and Pharmacy at Ho Chi Minh City; and Hoang Nguyen, MD, PhD, at Nova Southeastern University.

REFERENCES

1. Mossey PA, Little J, Munger RG, et al. Cleft lip and palate. Lancet 2009;374:1773–1785
2. Hsieh T-Y, Dedhia R, Del Toro D, et al. Cleft septorhinoplasty: form and function. Facial Plast Surg Clin North Am 2017;25:223–238
3. Allori AC, Mulliken JB. Evidence-based medicine: secondary correction of cleft lip nasal deformity. Plast Reconstr Surg 2017;140:166e–176e
4. Friel MT, Starbuck JM, Ghoneima AM, et al. Airway obstruction and the unilateral cleft lip and palate deformity; contributions by the bony septum. Ann Plast Surg 2015;75:37–43
5. Farkas LG, Hajnáš K, Posnick JC, et al. Anthropometric and anthroposcopic findings of the nasal and facial region in cleft patients before and after primary lip and palate repair. The Cleft palate-craniofacial journal 1993;30:1–12
6. Rokni AM, Kearney AM, Brandt KE, et al. Clinical practice patterns and evidence-based medicine in secondary cleft rhinoplasty: a 14-year review of maintenance of certification tracer data from the American Board of Plastic Surgery. Cleft Palate Craniofac J 2021;58:1110–1120
7. Crockett D, Bumstead R. Nasal airway, otologic, and audiologic problems associated with cleft lip and palate. In: Bardack J, Morris HL, eds. Multidisciplinary Management of Cleft Lip and Palate. Philadelphia, PA: WB Saunders; 1990:672–680
8. Jiang M, You M, Wang S, et al. Analysis of nasal septal deviation in cleft palate and/or alveolus patients using cone-beam computed tomography. *Otolaryngol Head Neck Surg* 2014;151:226–231

9. Trindade IEK, Bertier CE, Sampaio-Teixeira ACM. Objective assessment of internal nasal dimensions and speech resonance in individuals with repaired unilateral cleft lip and palate after rhinoseptoplasty. *J Craniofac Surg* 2009;20:308–314

10. Massie JP, Runyan CM, Stern MJ, et al. Nasal septal anatomy in skeletally mature patients with cleft lip and palate. *JAMA Facial Plast Surg* 2016;18:347–353

11. Kim NG, Park SW, Park HO, et al. Are differences in external noses between Whites and Koreans caused by differences in the nasal septum? *J Craniofac Surg* 2015;26:922–926

12. Lee J-S, Lee DC, Ha DH, et al. Redefining the septal L-strut in septal surgery. *PLoS ONE* 2015;10:e0119996

13. Kim J-S, Khan NA, Song HM, et al. Intraoperative measurements of harvestable septal cartilage in rhinoplasty. *Ann Plast Surg* 2010;65:519–523

14. Kim J, Han SH, Kim SW, et al. Clinical significance of the sphenoidal process of the cartilaginous nasal septum: a preliminary morphological evaluation. *Clin Anat* 2010;23:265–269

15. Toriumi DM, Bared A. Revision of the surgically overshortened nose. *Facial Plast Surg* 2012;28:407

16. Brandstetter M, Bhatt M, Pham M, et al. Comparative analysis and long-term results of various septal extension graft types. *Facial Plast Surg* 2020;36:263–267

17. Caughlin BP, Been MJ, Rashan AR, et al. The effect of polydioxyanone absorbable plates in septrhinoplasty for stabilizing caudal septal extension grafts. *JAMA Facial Plast Surg* 2015;17:120–125

18. Greives MR, Camison L, Losee JE. Evidence-based medicine: unilateral cleft lip and nose repair. *Plast Reconstr Surg* 2014;134:1372–1380

19. Lee SH, Koo MG, Kang ET. Septal cartilage/ethmoid bone composite graft: a new and improved method for the correction underdeveloped nasal septum in patients with short noses. *Aesthetic Plast Surg* 2017;41:388–394

20. Sazgar A. The bony cartilaginous unit: the missing graft in septrhinoplasty. *Int J Oral Maxillofac Surg* 2016;45:1006–1008

21. Kayabasoglu G, Yilmaz MS, Altundag A, et al. Bone grafts as a recyclable material in nasal surgeries. *Auris Nasus Larynx* 2015;42:24–28

22. Zins JE, Whitaker LA. Membranous versus endochondral bone: implications for craniofacial reconstruction. *Plast Reconstr Surg* 1983;72:778–785

23. Kim GR, Park K, Kim T. Use of nasal septal bone for septal extension graft after jaw surgery. *Plast Reconstr Surg Glob Open* 2013;1:e76

24. An Y, Xie L, Chen L, et al. Short nose correction: septal cartilage combined with ethmoid bone graft. *J Craniofac Surg* 2019;30:1898–1901

25. Holt GR. Biomechanics of nasal septal trauma. *Otolaryngol Clin North Am* 1999;32:615–619

26. Ketcham AS, Dobratz EJ. Normal and variant anatomy of the nasal tip. *Facial Plast Surg* 2012;28:137–144

27. Kim JH, Song JW, Park SW, et al. Effective septal extension graft for Asian rhinoplasty. *Arch Plast Surg* 2014;41:3

28. Dixon TK, Caughlin BP, Munaretto N, et al. Three-dimensional evaluation of unilateral cleft rhinoplasty results. *Facial Plast Surg* 2013;29:106–115