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Publication Date

2024-01-12

DOI

10.1089/fpsam.2023.0152

Facial Plastic Surgery & Aesthetic Medicine
Volume 0, Number 0, 2024

DOI: 10.1089/fpsam.2023.0152

Facial Plastic Surgery & Aesthetic Medicine

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Boomerang Modification of the Septal Extension Graft: Graft Design and Functional Outcomes

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Abstract

Background: A "boomerang" graft is an end-to-end caudal septal extension graft (SEG) that conforms to the geometry of the anterior septal angle, and avoids septal overlap, unlike a side-to-side SEG.

Objective: To compare breathing improvements in rhinoplasty patients receiving boomerang SEGs and patients receiving side-to-side SEGs.

Methods: Retrospective cohort analysis of patients undergoing rhinoplasty with either end-to-end boomerang SEG or a side-to-side SEG. Functional outcomes were assessed through the Nasal Obstruction Symptom Evaluation (NOSE) survey.

Results: The boomerang SEG cohort had a mean age of 34 years and were 68% female compared with 38 years and 67% female in the side-to-side SEG cohort ($p > 0.05$). The cohorts did not differ in the proportion of the lateral crural tensioning, spreader graft placement, or history of rhinoplasty. The boomerang cohort demonstrated a 67% reduction in NOSE scores compared with a 70% reduction among the side-to-side SEG cohort ($p = 0.14$). Men undergoing boomerang graft placement reported significantly less postoperative functional improvement than men undergoing placement of a side-to-side SEG (62% vs. 77%, $p = 0.01$).

Conclusion: Use of a boomerang graft is not likely to negatively affect rhinoplasty functional outcomes when compared with a side-to-side SEG.

Introduction

The septal extension graft (SEG) has gained popularity as a means to establish precise and durable tip position in both functional and cosmetic rhinoplasty.[1,2] Placement of SEGs involves suturing a cartilage graft to the native dorsal or caudal septum and then suturing the medial crura to the graft. The SEG can be a useful tool to improve nasal form and function in primary and revision cases. Patients with poor tip support, inadequate tip projection, excessive tip rotation, or inadequate columellar length are excellent candidates for SEG placement.[3–7] The SEG can also be used to maintain a patient's natural tip position against the effects of postoperative scar contracture and the natural tip ptosis that can occur with aging.

These grafts can be secured to the native cartilaginous septum in different configurations depending on the desired effect and the cartilage available for grafting. One study by Han et al. demonstrated marked aesthetic improvement in both side-to-side and end-to-end SEG

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KEY POINTS:

Question: Do patients have similar breathing improvement after rhinoplasty is completed using either a graft placed in front of the septum or beside it?

Findings: There was no difference in breathing improvement between patients with boomerang grafts placed in front of the septum compared with beside it.

Meaning: A boomerang graft is a practical choice when the septum is in the middle and there is limited cartilage for grafting.

placement.[8] Grafts can extend into the interdomal space and/or into the space between the medial crura. Side-to-side placement can offer the additional benefit of splinting a weakened or deviated caudal septum. Side-to-side placement is useful if the anterior septal angle (ASA) is slightly deviated to one side, as the SEG can reestablish a central midline.

The overlapping nature of the side-to-side SEG with the nasal septum may contribute to nasal obstruction due to encroachment of the internal nasal valve. However, a previous study has recently shown excellent cosmetic results of the side-to-side SEG without compromising nasal function.[9] Although most applications of an SEG will require a straight and flat piece of cartilage for grafting, a curved SEG can be used to achieve midline tip position when the caudal edge of the cartilaginous septum has an intrinsic curvature.[10–12]

One of the primary challenges in employing an SEG is harvesting adequate cartilage for all grafting applications. If spreader grafts, batten or strut grafts, and rim grafts are necessary, available septal cartilage becomes a precious commodity. Side-to-side SEGs often require a large piece of straight and flat cartilage to provide adequate overlap with the native caudal septum. Use of an end-to-end graft can help minimize the amount of cartilage necessary for an SEG while avoiding septal overlap and internal nasal valve bulk.[8]

When autologous septal cartilage is limited, and the ASA is in the midline, we advocate for creation of an end-to-end SEG in a ''boomerang'' configuration. This technique was reported by the senior author as a means to conserve septal cartilage while still achieving the necessary coaptation with the native caudal septum.[13] By designing the graft into a three limbed-boomerang shape, an SEG is constructed that is in-line with the septal centerline and conforms to the ASA.

This study compares whether patients undergoing rhinoplasty and receiving end-to-end caudal SEGs in the boomerang configuration show similar improvements in breathing compared with those who receive side-to-side caudal SEGs, as demonstrated by patient-reported functional outcomes.

Methods

"Boomerang" SEG technique

The boomerang SEG technique is illustrated in the Supplementary Video S1 and described as follows. During an open approach rhinoplasty, the soft tissue is dissected away from the underlying lower alar cartilages, the medial crura are separated, and the septum is exposed.[9] Nasal septal or costal cartilage are preferred when available for boomerang grafts as they are midline structures and must be very straight.

First, a template is used to outline the ASA. The senior author's preference is to press a sterile surgical gown pass card or cardboard packing material from a suture pack against the native septum, which in turn creates an ''ink blot'' of blood that outlines the border of the caudal septum. The domes of the lower lateral cartilages are then positioned to estimate the desired projection and rotation.

The shape of the desired graft is drawn on the cardboard, creating a precise template with the tip defining position, columellar curvature, and infratip break points clearly defined. In general, the senior author adds a bit of excess projection and counter-rotation when initially designing the template/graft as the graft can be trimmed when secured in situ.

The graft can then be sequentially trimmed to the preferred shape, with tapered extensions along the dorsal and caudal aspects of the native septum (Fig. 1). The graft is then sutured to the native caudal septum and held in place with Brown-Adson forceps by an assistant. The graft is secured with suture in a running or interrupted figure-of-eight manner; 5-0 PDS is preferred by the senior

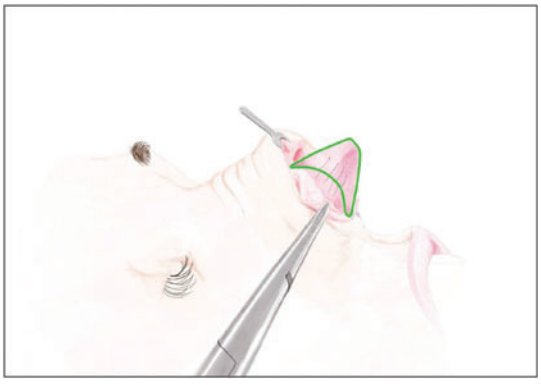

Fig. 1. A precise template is designed and centered over the anterior septal angle. The caudal and dorsal extensions are tapered. The graft is then held in place by an assistant while the surgeon secures the graft to the native septal cartilage. Running or interrupted figure-of-eight stitches can be used. 5-0 PDS suture is preferred by the senior author.

author. Once secured, the caudal aspect of the boomerang graft can be refined to optimize tip projection, rotation, and the infratip break geometry. Thin batten grafts made of cartilage shavings measuring 5–10 mm in diameter are used to reduce flexure. They are positioned on both sides of the SEG in an offset manner.

Study design and statistical analysis

This study was approved by the Institutional Review Board at the University of California, Irvine (IRB #20152490). A retrospective chart review of patients undergoing rhinoplasty procedures by a single surgeon (B.J.F.W.) was performed. All patients from October 2015 to November 2021 undergoing boomerang graft or traditional side-to-side SEG placement were included. Clinical outcomes were measured by the validated Nasal Obstruction Symptom Evaluation (NOSE) survey.[14] Individual data were analyzed based on completion of both pre- and postoperative NOSE surveys. Higher NOSE scores imply lower patient satisfaction regarding functional concerns.

The cohort of patients receiving boomerang grafts were grouped and characterized by perioperative characteristics and NOSE scores. These patients were then matched to a cohort of patients undergoing side-to-side SEG placement based on preoperative NOSE score, age within 5 years, and gender. These characteristics were chosen based on their previous use in a study published by Patel et al.[9] Clinical presentation, intraoperative variables, and common complications of rhinoplasty procedures, as previously defined by Heilbronn et al., were compared between the boomerang graft and the side-to-side SEG cohorts.[15]

Frequencies of revision surgery performed by the primary surgeon were collected and sorted into major and minor criteria. The distinction between a major and minor revision is arbitrary, but we use an operational definition. A minor revision is defined as a maneuver that can be performed in-office using local anesthesia without patient sedation.

Outcome comparisons were made between the boomerang graft and side-to-side SEG cohorts after stratifying by type of surgery (functional, cosmetic, or functional and cosmetic), prior nasal surgery (primary or revision), and gender (female or male). Univariate analyses were performed using an independent samples *t*-test for continuous variables and a chi-squared test for categorical variables. All statistical analyses were performed using SPSS Statistics version 27 (SPSS, Inc., Chicago, IL, USA). A *p*-value of <0.05 was considered statistically significant.

Results

Over the specified 6-year period, a total of 108 patients underwent placement of a boomerang graft. Five of the eligible patients who had a boomerang graft were excluded from analysis due to a lack of postoperative NOSE scores. These patients were matched to a cohort of 103 patients undergoing placement of side-to-side SEGs based on preoperative NOSE score, age within 5 years, and gender. Table 1 summarizes the demographic and intraoperative variables.

NOSE score outcomes are summarized in Table 2. Postoperative NOSE score follow-up duration was 4.76 months (±5.60) for the boomerang graft cohort and 8.43 months (±7.29) for the side-to-side SEG cohort ($p = 0.003$). Univariate analysis revealed a difference in the number of patients having rim grafts placed during surgery. This was done 73% of the time when a boomerang graft was used and 59% of the time when a side-to-side SEG was used ($p = 0.039$). There were no differences in the frequency with which other intraoperative maneuvers considered for analysis were performed (e.g., lateral crural tensioning, spreader grafts, and auto-spreader grafts).

Patients receiving boomerang grafts reported higher postoperative NOSE scores compared with side-to-side SEG patients (boomerang: 24.3 ± 26.4, side-to-side: 18.8 ± 18.8, $p = 0.009$). There was no difference in improvement in NOSE scores between patients receiving boomerang grafts and patients receiving side-to-side SEGs independent of the type of surgery performed or whether the patient underwent primary or revision surgery (Table 2). Men undergoing placement of a boomerang graft reported less improvement in their postoperative NOSE score when compared with men undergoing placement of a side-to-side SEG (61.8 ± 36.9 vs. 76.5 ± 22.3, $p = 0.013$).

There were no incidences of suture complications, septal abscesses, perforations, adhesions, septal deviations,

Table 1. Demographic and intraoperative variables in patients with and without boomerang grafts

Variables	*Boomerang SEG*	*Side-to-side SEG*	p
n	103	103	
Age, mean ± SD	33.9 ± 13.5	38.1 ± 14.9	0.058
Gender, *n* (%)			
Female	70 (68)	69 (67)	0.882
Male	33 (29)	34 (33)	
Follow-up interval (months)	4.76 ± 5.60	8.43 ± 7.29	0.003*
Prior nasal surgery, *n* (%)	14 (14)	28 (27)	0.184
Type of surgery, *n* (%)			
Functional	68 (66)	80 (78)	0.130
Cosmetic	35 (34)	23 (22)	
Intraoperative variables, *n* (%)			
Rim graft	75 (73)	61 (59)	0.039*
Lateral crural tensioning	28 (27)	12 (12)	0.217
Spreader	95 (92)	83 (96)	0.898
Auto-spreader	20 (19)	9 (9)	0.142

*Statistically significant, $p < 0.05$.
SD, standard deviation; SEG, septal extension graft.

Table 2. Nasal obstruction symptom evaluation outcomes in patients with and without boomerang grafts stratified by type of surgery, prior nasal surgery, and gender

Variables	*Boomerang SEG average NOSE score ± SD*	*Side-to-side SEG average NOSE score ± SD*	p
Overall	$n = 103$	$n = 103$	
Presurgery	64.7 ± 21.2	68.6 ± 19.8	0.820
Postsurgery	20.9 ± 23.7	19.3 ± 18.8	0.072
% Change	−67.0 ± 39.0	−70.1 ± 32.6	0.144
Functional rhinoplasty	$n = 68$	$n = 80$	
Presurgery	69.4 ± 19.4	68.6 ± 19.3	0.895
Postsurgery	24.3 ± 26.4	18.8 ± 18.8	0.009*
% Change	−64.5 ± 42.3	−70.4 ± 34.1	0.717
Cosmetic rhinoplasty	$n = 34$	$n = 23$	
Presurgery	58.0 ± 23.6	71.4 ± 22.0	0.644
Postsurgery	15.2 ± 14.8	23.1 ± 20.2	0.089
% Change	−69.9 ± 32.6	−67.5 ± 27.8	0.837
Primary rhinoplasty	$n = 89$	$n = 73$	
Presurgery	64.8 ± 20.7	68.0 ± 19.5	0.788
Postsurgery	20.2 ± 23.6	16.5 ± 16.6	0.130
% Change	−69.0 ± 39.7	−74.2 ± 26.9	0.244
Revision rhinoplasty	$n = 14$	$n = 30$	
Presurgery	64.1 ± 24.8	70.0 ± 21.0	0.641
Postsurgery	25.0 ± 24.5	26.2 ± 21.9	0.898
% Change	−61.1 ± 35.2	−58.0 ± 41.4	0.337
Men	$n = 33$	$n = 34$	
Presurgery	63.3 ± 19.8	69.9 ± 18.2	0.760
Postsurgery	22.7 ± 21.6	17.2 ± 17.0	0.191
% Change	−61.8 ± 36.9	−76.5 ± 22.3	0.013*
Women	$n = 70$	$n = 69$	
Presurgery	65.3 ± 21.9	67.9 ± 20.7	0.896
Postsurgery	20.0 ± 24.7	20.4 ± 19.6	0.221
% Change	−69.5 ± 40.0	−67.0 ± 36.3	0.823

*Statistically significant, $p < 0.05$.
NOSE, nasal obstruction symptom evaluation.

Table 3. Rhinoplasty complications in patients with and without boomerang grafts

Variables	*Boomerang SEG (n = 80)*	*Side-to-side SEG (n = 87)*	p
Infection			
Infection	4 (5)	9 (10)	0.198
Suture complications	0	0	NA
Septal abscess	0	0	NA
Skin soft tissue envelope			
Skin necrosis/dehiscence	0	0	NA
Framework/intranasal			
Obstruction	3 (4)	5 (6)	0.546
Perforation	0	0	NA
Adhesions	0	0	NA
Septal deviation	0	0	NA
Saddle nose	1[a] (1)	0	0.305
Valve collapse	1 (1)	0	0.298
Drooping nasal tip	0	0	NA
Revision	$n = 103$	$n = 103$	
Any	4 (4)	7 (7)	0.832
Major reason	2 (2)	5 (5)	0.467
Minor reason[b]	2 (2)	2 (2)	0.898

[a]The patient's postoperative course was uneventful; however, the patient underwent elective Le Fort osteotomy and maxillary-mandibular advancement by an oral maxillofacial surgeon after the initial surgery.
[b]Meets minor revision criteria if procedure can be performed in office without patient sedation.
CSF, cerebrospinal fluid.

or drooping nasal tips in any patient from either cohort. Three patients from the boomerang cohort reported nasal obstruction after surgery, whereas five patients in the side-to-side cohort reported the same issue ($p = 0.546$). In addition, four patients in the boomerang cohort required a revision procedure performed by the primary surgeon, compared with seven in the side-to-side cohort ($p = 0.832$). No difference was appreciated in any of the observed complications between the boomerang graft and side-to-side SEG cohort. These data are summarized in Table 3.

Discussion

The boomerang graft is a unique application of the SEG with a focus on maintaining midline tip position, especially when available cartilage for grafting is limited. The technique requires creation of a high-fidelity template of the ASA to create a custom-fitted end-to-end SEG. The graft is secured to the ASA with tapering extensions along the dorsal and caudal edges of the cartilaginous septum. The moniker of ''boomerang'' graft is due to the shape of the graft.

The bulk of the graft is positioned in the interdomal space such that the ideal tip position is established. This cohort analysis demonstrates a reduction in NOSE scores of 67% and 70% in patients receiving boomerang SEGs and traditional side-to-side SEGs, respectively. No difference in postoperative NOSE survey score improvement was noted when the two cohorts were grouped by goals of surgery (functional, cosmetic, functional and cosmetic) or a history of prior rhinoplasty (primary or revision).

Few studies compare outcomes among end-to-end and side-to-side SEGs. With regard to aesthetic outcomes, one study by Han et al. demonstrated marked aesthetic improvement in both SEG placements.[8] To our knowledge, no studies compare breathing outcomes among patients receiving either end-to-end or side-to-side SEGs. This study adds to the current literature by providing analysis of functional outcomes in patients receiving a boomerang end-to-end SEG in comparison with traditional side-to-side.

Of note, the boomerang graft employs an end-to-end configuration, distinct from the conventional side-to-side SEGs, avoiding overlap with the caudal septum. This variance minimizes internal nasal valve bulk, potentially contributing to improved breathing outcomes. However, this study demonstrates improvements in NOSE scores with patients receiving either SEG, and advocates for graft selection based on available cartilage and the orientation of the native caudal septum.

Primary rhinoplasty cases requiring multiple cartilaginous grafts present a design challenge to the surgeon hoping to avoid a second cartilage donor site. Revision cases can offer the same challenge, regardless of the number of grafts anticipated to be necessary. This same principle

applies to patients undergoing primary rhinoplasty with a history of prior septoplasty. Use of the boomerang graft accommodates excellent tip support with reduced cartilage utilization.

Although the side-to-side SEG is occasionally used to establish midline tip position when the native caudal septum has mild intrinsic curvature or deviation,[10,11,14] its use may be problematic when the ASA is already perfectly midline. In contrast, the boomerang graft allows preservation of a midline nasal tip, especially when the caudal septum is not deviated.

When compared with a side-to-side SEG, the boomerang graft presents technical challenges. The posterior edge of the graft must mirror the curvature of the ASA; ideally fit like pieces of a puzzle. If there is significant variation, unintended torque can be applied to the native caudal septum when securing the graft. Surgically, the graft is not able to be stabilized with hypodermic needles as can be done with a side-to-side graft. As such, a second set of attentive hands is helpful when securing the boomerang graft. The boomerang graft may be more likely to be used when cartilage for grafting is scarce. This was evident in our study by the fact that the boomerang graft was more likely to have been used when rim grafts were also placed.

One benefit of the side-to-side SEG is the additional stability provided to the native caudal septum.[10,11,14] This can be useful, and even necessary, when the structural integrity of the native caudal septal cartilage is lacking. One strategy to mimic this effect when using the boomerang graft is to attach small batten grafts to one or both sides of the boomerang graft (Supplementary Video S1). These thin batten grafts span the articulation between the ASA and the boomerang graft and should be about 0.5 mm in thickness.

Small irregularly shaped fragments of cartilage can be effectively used for this purpose. These can often be obtained from thick cartilage specimens that must be meticulously sliced to be made thinner for grafting. The side-to-side SEG configuration was recently demonstrated to confer no penalty in postoperative functional outcomes.[9] Additional studies are necessary, but based on these findings, one would not expect small septal batten grafts to significantly impair functional outcomes.

Design of Neves et al.'s ASA banner graft was based on the principle of minimizing torque on the SEG and adding stability through its tapered edges.[16] In this respect, the smaller boomerang graft is designed to resist rotational force from the lower lateral cartilages. Further analysis of preservation of tip position over time when using a boomerang graft could influence the scope of its surgical applications.

One of our results demonstrated that men undergoing placement of a boomerang graft reported less improvement in their postoperative NOSE scores compared with men undergoing placement of a side-to-side SEG. This difference may be due to the fact that the boomerang group had a lower baseline NOSE score. Despite less improvement, the change in pre- versus postoperative NOSE scores still meets the minimal clinically important difference for functional improvement, which is a change of 24 points.[17] Therefore, although statistically significant, the difference in improvement between the two groups is not likely to be clinically significant.

Although this study is the first comprehensive analysis of functional outcomes in patients receiving boomerang SEGs in comparison with traditional side-to-side, it is not without limitations. The relatively small sample size, the retrospective nature of the study, and possible omission of confounding intraoperative variables limit cause-and-effect analysis. In addition, the limited postoperative follow-up interval limits the ability to assess longitudinal outcomes >12 months, although previous studies have demonstrated that the natural history of the NOSE score does not change after 1 month.[18]

Conclusion

The boomerang graft is a minimalist application of the SEG that produces reliable improvements in functional outcomes in primary and revision rhinoplasty. This study supports the use of the boomerang graft when rhinoplasty surgeons require precise tip control, when the ASA is already midline, or when available cartilage is limited. Additional research will help better define the role of supporting batten grafts used in tandem with the boomerang SEG. In addition, future avenues of research would benefit from further characterization of tip control, including projection, length, and rotation in this cohort.

Acknowledgment

We thank Anjali Herekar, BS for her artistic contribution to Figure 1.

Authors' Contributions

Conception and design of study by R.D.P., A.A.H., and B.J.F.W. Acquisition of data by M.V., A.H., K.K.D., and T.V.N. Analysis and/or interpretation of data and drafting the article by R.D.P., M.V., A.A.H., and B.J.F.W. Revising the article critically for important intellectual content and approval of the version of the article to be published by R.D.P., M.V., A.A.H., K.K.D., T.V.N., A.H., and B.J.F.W.

Disclaimer

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the article.

Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in *Facial Plastic Surgery and Aesthetic Medicine*

Author Disclosure Statement

No competing financial interests exist.

Funding Information

No funding was received for this article.

Supplementary Material

Supplementary Video S1

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