

EFFECTIVENESS OF AUTOLOGOUS COSTAL CARTILAGE GRAFT IN AUGMENTATION RHINOPLASTY

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Abstract

Rhinoplasty is the most demanding aesthetic procedure that is currently shifted from ablative to conservative surgical procedures, one of these procedures is using cartilage grafts for correction and augmentation of congenital and acquired nasal deformities. The Autologous costal cartilage graft (ACCG) is a good choice for reconstruction of these deformities because its ample amount and good strength.

The aim of this study is to assess the outcome of using autologous costal cartilage graft in augmentation rhinoplasty in severe congenital and acquired nasal deformities.

This is a prospective study of 10 patients aged between 16-45 years (7 females and 3 males) in form of 4 cases of saddle nose, 3 cases of cleft lip nasal deformity, two cases of post-traumatic severely deviated nose, and one case of African nose. Patients underwent augmentation rhinoplasty by ACCG, from July 2018-June 2019. The follow-up period was 6-12 months concentrating on preoperative and postoperative structural and functional evaluation.

The outcome of augmentation rhinoplasty by ACCG was evaluated by 2 independent surgeons and the results were accepted by both surgeons and patients in 9 out of 10 cases (apart from one case that she had infection of the graft) with donor site complication rates near to the related studies.

In conclusion, ACCG is one of the best choices for severe nasal deformities that need ample amount of cartilage for structural and functional support and good aesthetic outcome with low complication rate.

Keywords: Autologous graft, Costal cartilage, Surgery, Rhinoplasty, Augmentation.

Introduction

Rhinoplasty is considered the most demanding procedure in plastic surgery. Performing rhinoplasty successfully with consistent results requires an adequate workload of cases, a sound knowledge of anatomy including functional anatomy, and a methodical study of a vast body of literature¹.

Although rhinoplasty is a complex procedure, according to the American

Society of Plastic Surgeons (ASPS), over 350,000 rhinoplasties were performed in the United States in 2003, making it one of the most common cosmetic surgical procedures². Over the past 20 years, the trend in rhinoplasty has shifted from ablative techniques involving reduction or division of osseocartilaginous framework to techniques that preserve native anatomy. Cartilage sparing suture

techniques and augmentation of the deficient areas to correct contour deformities and restore structural support are commonly employed³.

Because cartilage is a normal component of the native nasal structure, it is logical to use it to replace deficiencies and create structure, contour, and aesthetic enhancement. Cartilage grafts are equally suited for structural support of the nose as well as non-supporting applications such as camouflage grafts. The graft can be of variable rigidity based on site of harvest and how they are modified prior to use. A whole spectrum of graft strength, thickness, volume, and malleability can be achieved by use of septal grafts, auricular grafts, costal cartilage grafts, or combination. Thick or rigid grafts are best suited for supporting applications. Thin grafts are useful when minimal visibility is desired as in areas of thin skin over the nasal dorsum or in revision cases. Stacked and sutured grafts can help to create greater support or can be used in augmentation cases when significant augmentation is required⁴.

Nasal augmentation has many specific uses in aesthetic rhinoplasty. These include correction of disproportionately low radix, insufficient dorsal nasal profile, inadequate projection of the nasal tip, alar collapse, and columellar recession. Nasal grafts are almost always needed in non-caucasian rhinoplasty. Black, Asians, and mestizo noses each have own particular configuration; corrective nasal surgery should be performed bearing in mind the natural facial aesthetics of patient's race. Cartilage graft in aesthetic rhinoplasty is the rule rather than exception in secondary rhinoplasty and cleft lip rhinoplasty⁵.

Rib Cartilage Graft: A substantial amount of rib cartilage and bone may be harvested from one or several different ribs to provide material for reconstruction of large defects. Rib cartilage is hyaline and undergoes extensive ossification with advancing age⁶.

Prior to the harvest of rib cartilage graft, we should do preoperative evaluation for any history of augmentation mammoplasty, previous costal cartilage harvest and chest wall trauma. A chest x-ray is mandatory for the elucidation of old fracture of costal cartilage and bone, calcification, or the ossification of costal cartilage. Calcification of costal cartilage begins around mid 30s and becomes more frequent finding in older patients⁷.

Aims of the study:

1-Evaluation of the effectiveness of costal cartilage graft in Augmentation rhinoplasty for achievement of pleasing aesthetic and functional results by:

a- Maintenance of tip projection.
b- Restoring of rigid dorsal stability of the nasal vault.
c- Keeping of patency of the nasal valves.

2- Evaluation of the donor and recipient site morbidities and the proper techniques that are required and comparing these techniques and results with other related studies.

Patients and Methods

This prospective study was done between July 2018 to June 2019 at Al-Sadr Teaching Hospital in Basrah, involving ten patients who underwent augmentation rhinoplasty by using autologous costal cartilage graft. Patients' age ranged between 16-45 years. Patients' data and diagnosis are shown in tables I & II.

Table I: Patients diagnosis.

Patients diagnosis	No .of cases
Saddle nose	4
Cleft lip nasal deformity	3
Severe trauma of the nose	2
African nose	1
Total	10

Table II: The data of the patients.

Patient	Age (years)	Gender	Diagnosis	Associated procedure
1	17	M	Severely traumatic deviated nose	Septoplasty
2	45	F	Saddle nose	Non
3	17	F	Saddle nose	Non
4	31	F	Saddle nose	Non
5	16	F	Cleft lip nasal deformity	Lip revision
6	28	M	Severely traumatic deviated nose	Septoplasty
7	19	F	Saddle nose	Non
8	19	F	Cleft lip nasal deformity	Non
9	19	M	Cleft lip nasal deformity	Forked flap
10	29	F	African nose	Non

Inclusion criteria: In this study, all included patients who required costal cartilage for augmentation rhinoplasty were involved depending on the inclusion criteria for this study:

1- Patients with severe congenital nasal deformities associated with severe deficiencies of dorsal height and severe alar collapse (cleft lip and congenital saddle noses).

2- Ethnic groups that have short, saddle and broad noses that need strong structural support for Augmentation of the nasal dorsum and tip projection. (Asian nose, African nose).

3- Patient who presented with history of severe nasal trauma or planned for revision rhinoplasty because of severe structural and functional problems that are not resolved by septal or auricular cartilage grafts.

Exclusion criteria:

1- Patients who have short follow-up period less than 3 months.

2- Patients who have insufficient preoperative or postoperative data and/or photo recordings.

3- Patients who underwent body dysmorphic disorder or unrealistic expectation.

Preoperative assessment:

Preoperative detailed history and examination were conducted for all patients. The subjective preoperative nasal analysis was also done with focusing on the type of the nasal skin, nasal dorsal depression, tip projection, nasal length, dorsal nasal width and deviation of the nose.

Functionally, the assessment of nasal breathing difficulties, internal nasal valve collapse, septal deviation, and sinusitis were diagnosed by consultation of otolaryngologist surgeon.

Donor site assessment was done to exclude any previous scar or congenital anomalies of the chest wall.

Preoperative chest x-ray PA view, complete blood count, blood urea, random blood sugar, and viral markers analysis were done to all patients with informed consent including agreement of patients to require their photographs in this work.

Operative procedure:

All operations were operated upon under general anesthesia using open approach rhinoplasty. After disinfection of the face and thoracic region, the operation begun by infiltration of 1% lidocaine with 1:200,000 adrenaline along transcolumellar incision, nasal tip, site of osteotomies and nasal septum. Local infiltration was done along the site of harvesting of costal cartilage to reduce bleeding and postoperative pain.

Open rhinoplasty started through inverted V-shaped incision that was done in the middle of the columella together with marginal incision along nasal alae, then, by using blunt scissor, the dissection proceeded below superficial musculoaponeurotic system (SMAS) to expose the lower lateral cartilage and osseocartilaginous vault. Bilateral submucoperichondrial dissection was done along both sides of the septum to expose it.

Both medial and lateral osteotomies were conducted in some study cases with conservative excision of the cephalic portion of the lower lateral crurae with maintaining at least 6 mm width of it. Septoplasty of the deviated septum was done for cases who had septal deviation.

The harvesting procedure of the costal cartilage graft: In all cases, the harvested costal cartilage was chosen on the right side of the patient for easy access by the

surgeon and also to avoid confusion between postoperative pain by harvesting and any accidental left sided chest pain due to cardiac cause⁸.

Costal cartilage graft harvesting began by selecting the required rib for its harvesting which was in females selected along the inframammary fold corresponding nearly to 6th rib, while in males along the 9th rib. At least 3 cm slight oblique or transverse incision was done extending from the right lateral border of the sternum.

After incising the skin and subcutaneous tissue, the fascia overlying the external oblique and rectus abdominis muscles are spread apart then, by electrocautery the muscle fibers are departed, in later cases the muscles were separated rather than cut them to decrease bleeding and postoperative pain.

All the remaining tissues overlying the rib were cleared off for better visualization. The perichondrium of the rib was incised by No.15 blade in an H-shaped fashion with two vertical incisions along the lateral and medial part of the costal cartilage and horizontal incision connecting both of them. The perichondrium was carefully elevated from the cartilage using freer from lateral portion of the costal cartilage at its articulation with rib bone toward the medial side till reaching the desired length of cartilage. After adequate freeing of the cartilage from its overlying perichondrium, the desired length of costal cartilage was incised by No.15 blade, while the cartilage was carefully elevated by freer from its underlying bed as demonstrated in Fig 1.

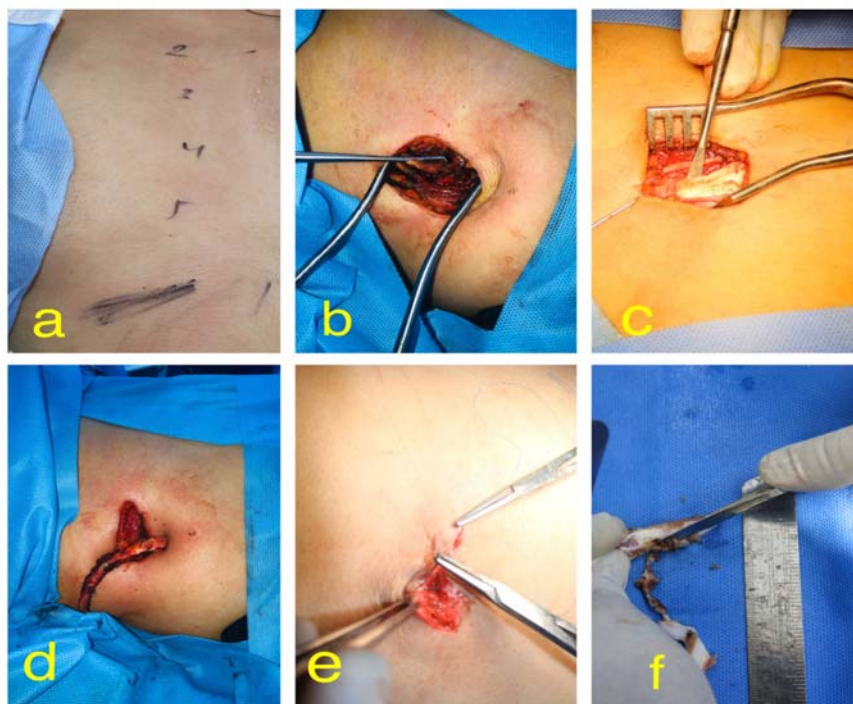


Fig 1: Planning and surgical steps of harvesting the costal cartilage: A: determination of harvested cartilage, B: incision of skin, fascia and muscle, C: freeing of cartilage from its perichondrium, D: excision of desired length of cartilage, E: multilayered closure of incision, F: concentric carving of the cartilage.

After completing the harvesting of the cartilages, air leakage was examined by filling the pocket (which resulted from harvested cartilage) by normal saline solution while the anesthesiologist initiated positive pressure ventilation to ensure that there is no air bubble from the pocket which indicates a pleural tear. After ensuring there was no pleural tear, the perichondrium was closed by using 3-0 polyglactin suture, the cut muscle fibers were sutured also by 3-0 polyglactin suture. We injected the muscle, fascia and skin with 10ml of Bupivacaine (Marcaine) to reduce postoperative pain. The skin was closed in 2 layers by dermal interrupted 3-0 polyglactin suture and 3-0 nylon subcuticular suture. No drain was used and the donor site was dressed.

The harvested cartilage was immersed in normal saline solution for at least 15 minutes. The graft cut parallel to its long axis and its central portion was carved according to the required nasal deformity.

For those cases which required nasal dorsal augmentation at least 3-5 cm in length of costal cartilage was inserted above the osseocartilaginous vault, sometimes the graft was fixed by two nasofrontal pullout sutures. These two sutures fixed externally on the skin over the gauze to avoid stitch marks. When costal cartilage used as spreader graft, it was inserted bilaterally along both sides of the septum and upper lateral cartilage, and fixed in its position by using horizontal mattress 4-0 polydioxanone suture. Columellar strut graft was required in all study cases and fixed it in its position between the medial crurae using buried horizontal mattress 4-0 polydioxanone sutures. Onlay alar crural graft was used in 4 cases where the costal cartilage was carved to about 10-7-1 mm in dimensions and fixed to the lateral crura by 4-0 polydioxanone suture.

After finishing of cartilage graft inseting, the incisions were closed, and

internal nasal packing or a splint was inserted with an external nasal splint.

Post operative care: All patients were kept on regular medication in form of ceftriaxone infusion 1 gm daily for 2 days, then shifted to oral cefixime capsules 400 mg daily for 7 days, topical fucidic acid cream for incisions, and pain killers in form of tramadol ampule 100 mg intramuscularly at 0 day, then shifted to acetaminophen tablets 500 mg tds.

Patients were discharged in next day when the internal nasal packing was removed. The external skin sutures, the external splint, internal splints and pullout sutures were removed at 10th postoperative day. Subcuticular sutures of the donor site were removed at 14th postoperative day. The follow-up period extended at least 6-12 months postoperatively with average period of 7.4 months.



Fig 2: Dorsal onlay graft for 19 years old female with congenital saddle nose for dorsal augmentation.



Fig 3: A 17 years old male patient with severe nasal trauma and breathing difficulty which was corrected by bilateral spreader graft.

Results

Ten patients underwent augmentation rhinoplasty using costal cartilage. We used columellar strut graft in all patients. In nine patients, costal cartilage graft for dorsal augmentation was used. In four

patients, we used costal cartilage graft as onlay lateral crural graft, and one patients who had traumatic nasal deviation with nasal breathing difficulty was managed by spreader graft as shown in table III.

Table III: Types of ACCGs required in this study.

Type of graft	No. of cases
Dorsal onlay graft	9
Columellar strut graft	10
Lateral crural onlay graft	4
Spreader graft	1

The assessment was conducted by two independent surgeons and the results were accepted in 9 out of 10 patients. None of them had lost their dorsal projection and all of them maintained their nasal tip projection. For this case who had internal nasal valve collapse, he was successfully corrected. Those patients who had alar collapse, the only alar crural graft was used. Their alar contour was adequately corrected with accepted results. In all patients, no costal cartilage resorption was noticed and their

results were maintained during the follow-up period which was extended up to 6-12 month. No revision rhinoplasty was needed. One of the involved patients had minor cartilage infection with discharging sinus at the dorsum of the nose, this patient was treated conservatively with no sequelae. But she was not satisfied with the outcome of the surgery.

No donor site morbidity was noticed except hypopigmented scar in African shaped nose.



Fig 4: A 45 years old female patient has short saddle nasal deformity. The ACCG was harvested from right 6th rib to do dorsal onlay and columellar strut grafts for dorsal augmentation and tip projection, no donor or recipient sites complication. The post operative follow-up period was 10 months.



Fig. 5: A 29 years old female patients with criteria of short African nose, augmentation of the nose was achieved by dorsal onlay and columellar strut grafts harvested from right sixth rib cartilage, she had visible scar in the donor area, the follow-up periods was 6 months.

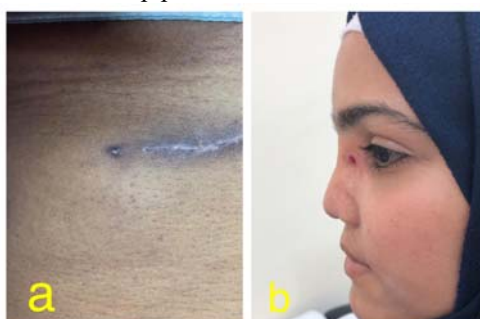


Figure 6: Complications of a; donor site: visible scar in African nose after 6 months. b; recipient site: purulent discharging sinus in the first few weeks after surgery which was treated conservatively.

Discussion

In the era of recent rhinoplasty, the rhinoplastic surgeon is often in need of ample amount of cartilage graft material for a variety of uses such as nasal dorsal augmentation, nasal septal reconstruction and for nasal tip surgery. Because of rhinoplasty become one of the most common aesthetic procedures, there is an increase number of secondary, tertiary and even quaternary cases which are associated with severe deformity and need autogenous cartilage graft. In spite of the availability of alloplastic materials that can provide a good alternative for using autologous graft, these implants are still associated with many complications like extrusion, Infection, thinning of the overlying skin and chronic pain⁹⁻¹¹.

Both auricular and septal cartilage grafts have a limited strength which is needed usually for posttraumatic, or congenital nasal deformities. however, many authors are hesitated to use the costal cartilage graft in rhinoplasty because of costal cartilage graft tends to warp due to its histologic ,anatomic, and physical characters and also due to the its donor site morbidity^{10,12,13}.

In this study autologous costal cartilage graft was used successfully in 9 out of 10 patients who did augmentation rhinoplasty using costal cartilage graft.

In this study, costal cartilage was used in form of structural graft as columellar strut to control the nasal projection and stabilization of nasal tip, also used as a spreader graft for this case that had internal nasal valve collapse with difficulty in nasal breathing, as contour graft for contouring of nasal ala in those patients with cleft lip nasal deformities and case of severe nasal deviation who had collapse of lateral crura where the costal cartilage was used as onlay graft to camouflage the lateral crura irregularities. Also costal cartilage in this study was used as enhancement graft for dorsal

nasal augmentation for those patients whomever had saddle, short and broad nose. All of these techniques were done for achieving the desirable aesthetic and functional results with a stable, a smooth nasal dorsum , an adequate tip projection, a pleasing alar contour, and functionally for improving the nasal breathing for this patient that had internal nasal valve collapse where the costal cartilage used as spreader graft.

Only one of the studied cases had purulent discharge from sinus in the upper part of dorsum which was managed conservatively. In all of the cases we encountered no immediate donor site morbidity like iatrogenic pneumothorax, hematoma, seroma or wound infection, apart from hypopigmented scar in dark-skinned patient, also no late donor site morbidity was encountered like chest wall deformity during follow-up period which was extended to 6-12 months. In this study, harvesting of costal cartilage was done with preservation of intact perichondrium that repaired after costal cartilage harvesting. We repaired the muscles and fascia for obliteration of dead space and thus avoiding the seroma formation because in one of large database studies which was done by Varadharajan et al., they found that incidence of seroma was (0.6%) after costal cartilage harvesting¹⁴, while in the current study, no seroma was reported, this rate may be due to low number of cases of this study.

We routinely injected Bupivacaine in the muscle after costal cartilage harvesting in order to reduce the postoperative pain which is considered as the most common complication, also in late cases of the series; we advocated muscle sparing technique rather than cut it for reducing of postoperative pain .Berke etal found that use of muscle sparing technique decreases the resting and movement pain postoperatively¹⁵. During harvesting of

costal cartilage we practice extreme caution to avoid pleural injury with cooperation of anesthesiologist to do positive pressure ventilation after filling of dead space by normal saline solution to ensure that there is no plural tear before closure. The overall complication rate in the donor site of costal cartilage was estimated to be (3.2%)¹⁴. While in the present study was 10% owing to hypopigmented scar which may be due to darkness of skin of the patient, this outcome is not due to iatrogenic cause.

Costal cartilage graft was used in augmentation rhinoplasty by Muhammad Saeed¹⁶ in 60 patients who had saddle nasal deformity between 2007-2012. His result showed that the overall success rate was up to 100% with no revisional surgery was needed and donor site morbidity was 12%. He stated that Cervelli L et al had shown that using costal cartilage in augmentation rhinoplasty associated with 94% success rate and Kami et al had 78% success rate with using of costal cartilage in augmentation rhinoplasty.

These studies if compared with the current results have a near success rate. However, the study which was done by Moon et al showed that using autologous costal cartilage in rhinoplasty is associated with high complication rate together with poor aesthetic outcome. In Moon et al study, they reviewed data of 108 patients who underwent augmentation rhinoplasty with using costal cartilage, their result showed that 73 patients satisfied, 16 patients stated that they became better when comparing with preoperative appearance, and 19 patients were completely unsatisfied¹², while in the present study, satisfaction rate was 90%. There were 13 donor site morbidities including seroma. Recipient site complications in Moon et al study were infection, resorption, visible graft, fraction of graft and warping. The infection rate in their study was 5.1% and

about 56% of infection occurred in revision rhinoplasty, they attributed this due to poor blood supply in recipient area which occurred due to scarry tissue from previous operation¹², in the current study, the complication rate of recipient site was 10% in form of infection with sinus. Araco et. al. had shown that the aesthetic result was much more when using septal or auricular cartilage graft for augmentation rhinoplasty than using costal cartilage¹⁷. However, other studies showed excellent aesthetic results and low complications when using costal cartilage graft in augmentation rhinoplasty^{18,19}. The most devastating complication which is related to costal cartilage is that warping. Warping by definition is referred to cartilage graft which leads to variety of structural deformities that affected the aesthetic outcome of appearance of the nose after rhinoplasty whom costal cartilage was used for augmentation rhinoplasty. The incidence of warping range from 0%-26.1% and the overall rate of cases that need revision rhinoplasty after warping was estimated to be 5.4%¹⁴, while in the present study, warping rate was 0% due to proper harvesting and carving technique that were used by many authors to avoid this sequelae.

There are many techniques that have suggested to decrease the tendency of warping, these include concentric carving of the cartilage, immersion of the costal cartilage in normal saline, internal K-wire fixation and using of oppositional suture of peripheral segment of cartilage^{20,21}. Removal of eccentric portion of the cartilage with using the central part of the cartilage together with immersion in normal saline has been showed to reduce warping of the costal cartilage in many studies and we utilized this method in the current study and it showed to be effective. So, the incidence of warping in the present study was 0%. It had been shown that the peripheral portion of the

costal cartilage graft is more prone to warping²¹. In study which was done by Balaji it had been shown that the high calcified the cartilage had less incidence of warping and also shown that central part of costal cartilage had less incidence of warping. Although Balaji showed that warping is not related to age or gender. However, presence of gritty calcified costal cartilage is directly related to age which makes warping more likely to have occurred in a young age group¹¹.

Using costal cartilage in the form of laminated dorsal graft had been suggested by some authors to decrease warping. However, this type of cartilage is fragile and does not provide sufficient strength and its resorption rate is greater than mono-unit costal cartilage graft¹². In the

current study when using costal cartilage as mono-unit cartilage, the resorption rate was 0%.

Conclusion and Recommendation:

1- the use of costal cartilage graft for augmentation rhinoplasty has shown to have a good and satisfying aesthetic and functional outcome.

2-The proper surgical techniques of harvesting, carving, and inseting of the costal cartilage graft in augmentation rhinoplasty gave us minimum donor site morbidity, low risk of warping and resorption of graft.

3-We are planning to continue to increase sample size of the study because of low number of cases and also to prolong the follow-up period to confirm the results and the outcome.

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