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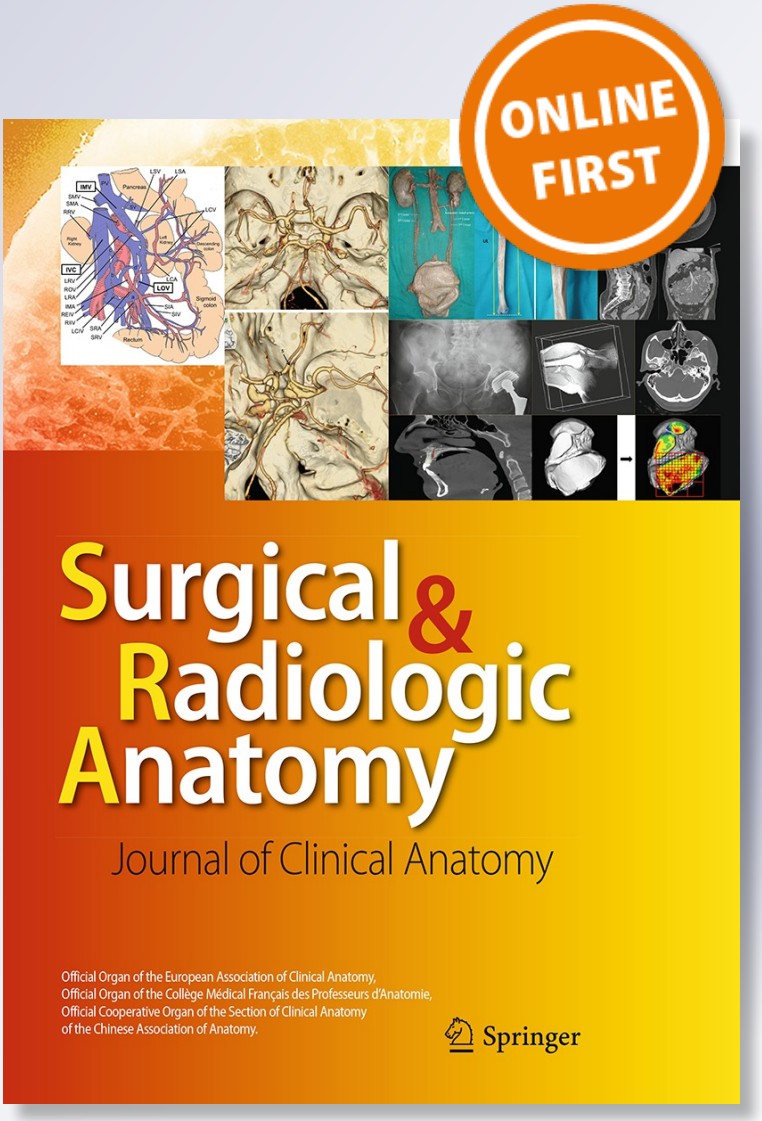

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ORIGINAL ARTICLE

A unilateral septal flap based on the anterior ethmoidal artery (Castelnuovo's flap): CT cadaver study

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Abstract
Objective We describe our experience for repair septal perforation with a septal flap and we analyse the route of the septal branch of the anterior ethmoidal artery (AEA) in the septum area with a radiological anatomy study in order to perform this flap.
Study design We carry out a prospective analysis with computed tomography scan in the cadaver heads and we perform an endoscopic technique in the patients.
Methods Ten nasal cavities were analysed in five adult cadaveric heads and two patients diagnosed with anterior septal perforation were surgically treated. Measurements in the cadaveric heads were obtained from a sagittal plane of the nasal septum. The anterior point corresponds to the projection of the anterior insertion of the middle turbinate in the frontal process of the maxilla over the nasal septum. The posterior point was obtained with a vertical line passing through the entrance of the AEA in the nasal septum.
Results The mean distance between the anterior point and the posterior point was 7.35 mm with a standard deviation of 0.95 mm. The lowest value was 5.5 mm and the highest value was 8.7 mm. We observed good epithelialisation and closure of the perforation in all patients.
Conclusion The unilateral septal flap pedicle by anterior ethmoidal artery may be used for small and medium perforations with a pedicle smaller than 1 cm posterior to the axilla.

Keywords Ethmoidal artery · Endoscopic approach · Flap · Septal perforation · Castelnuovo

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Introduction

Nasal septal perforation is a defect of the nasal cartilage and/or nasal bone septum with an approximate prevalence of 1 % in an adult population, although it has probably been underestimated because many patients remain asymptomatic [15]. The main cause is traumatic: surgery, septal cauterization, nose picking, drug consumption, topical corticosteroid treatment or substance inhalation. Other causes may be associated to systemic diseases or malignant tumours. Regarding the surgical causes mentioned above, around 1–5 % of septal perforation appear after a septoplasty, and between 17 and 25 % after submucous resection [6, 18].

Septal perforations can be divided into anterior (Cottle's area I–II–III) and posterior (Cottle's area IV–V). Posterior perforations are usually asymptomatic due to the presence of the turbinate area, but anterior defects often present symptoms such as crusting, nasal obstruction, recurrent bleeding, dryness, whistling or pain [12]. According to size, septal perforations can be classified as small (<1 cm in diameter), medium (1–2 cm) and large (>2 cm) [10].

There are different surgical treatment options to close the perforation. These include external and endonasal techniques, sublabial approaches, midfacial degloving and endoscopic procedures. Surgical outcomes show high success rates for small and medium perforations. However, these results diminish clearly in the large perforation closures [4, 10]. Among the patients treated with the endonasal approach the use of different rotation flaps, unilaterally and bilaterally, with or without interposed grafts for the coverage of the perforation has been reported [1, 16, 17, 19]. Castelnuovo et al. [2] described an endoscopic repair of anterior septal perforation using a unilateral septal flap based on the anterior ethmoidal artery (AEA). Our aim is to describe our experience with this septal flap and to analyse the route of the anterior ethmoidal artery in the septum area with a radiological anatomy study.

Materials and methods

Ten nasal cavities were analysed in five adult cadaveric heads provided by the Department of Anatomy of the Faculty of Medicine of the University of Alicante. All the specimens used were fresh-frozen prepared and preserved according to the Thiel's technique [9, 20, 21]. A multidetector computed tomography scan was performed using a series of contiguous 1.0 mm axial sections with a 512 × 512 pixel matrix without a gantry tilt, covering the whole head (including the nasal fossae). Measurements were obtained from a sagittal plane of the nasal septum from anterior (A) to posterior (B) using multiplanar reconstructions. The anterior point (A) corresponds to the projection of the anterior insertion of the middle turbinate in the frontal process of the maxilla (middle turbinate axilla) over the nasal septum. The posterior point (B) was obtained with a vertical line passing through the entrance of the AEA in the nasal septum (Fig. 1).

Two patients diagnosed with anterior septal perforation were surgically treated in our ENT department at Santa Creu i Sant Pau Hospital of Barcelona. Both patients referred bilateral nasal obstruction, dryness and one of them suffered from whistling. The patients were males aged 35 and 42 years. One patient had been previously operated from a septoplasty and the other patient's septal perforation was attributed to unknown causes.

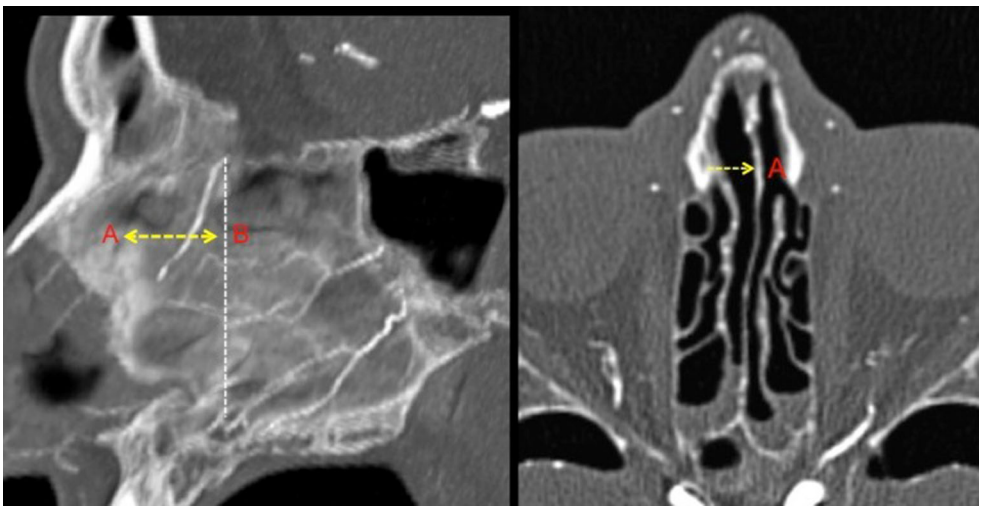

Fig. 1 The CT cadaver shows the measurements obtained from a sagittal and coronal plane. **a** Projection of the axilla in the frontal process of the maxilla over the nasal septum. **b** *Vertical line* passing through the entrance of the AEA in the nasal septum

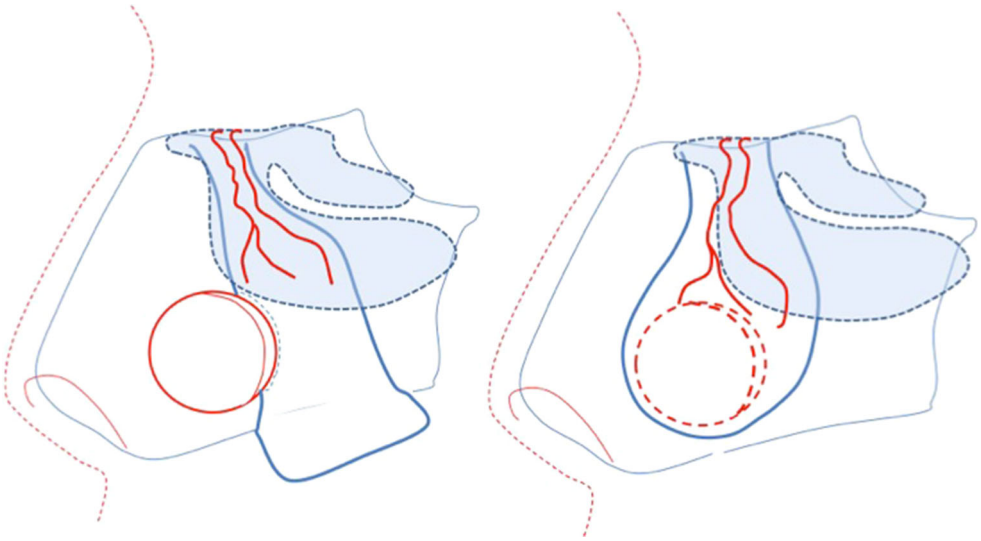

Fig. 2 The drawing shows the pattern of the Castelnuovo's technique

The perforations were located in the anterior Cottle's area with a size of 1 and 1.2 cm, respectively, using a Cottle septum elevator and a rule for the measurements. In both cases we confirmed the presence of septal integrity, cartilaginous or osseous, behind the posterior edge of the perforation. The patients were under endoscopic surveillance for 1 year.

An endoscopic endonasal approach was performed under general anaesthesia, using a 0° rigid endoscope. We examined the nasal fossa and performed curettage to the edges of the perforation. Then we began the surgical procedure designing two vertical incisions and an inferior incision according to Castelnuovo's technique [2] (Fig. 2). The nasal cavity was packed for 24–48 h and the patients were discharged the day after surgery. We placed a bilateral silastic sheet for 3 weeks.

Results

The mean distance between the anterior point (A) and the posterior point (B) was 7.35 mm with a standard deviation (SD) of 0.95 mm. The lowest value was 5.5 mm and the highest value was 8.7 mm. The median was 7.25 mm.

In the left fossa the mean was 7.02 mm with a standard deviation (SD) of 0.73 mm. In the right fossa the mean was 7.68 mm with a standard deviation (SD) of 0.84 mm (Table 1).

We observed good epithelialisation and closure of the perforation in both cases (Fig. 3). One patient remains asymptomatic and the symptoms of the other patient have improved, but showing a mild unilateral nasal obstruction due to the excess of flap in the septal area. Neither of the patients suffered from postoperative complications.

Table 1 Measurements obtained from anterior (A) to posterior (B) points in the cadaveric nasal cavities

Nasal fossae	Point A–point B (mm)
1 R	6.4
1 L	7.3
2 R	7.1
2 L	6.7
3 R	7.8
3 L	7.2
4 R	8.4
4 L	8.4
5 R	8.7
5 L	5.5
Mean	7.35
SD	0.95

R Right, *L* Left

Discussion

Surgical treatment for the closure of septal perforation is a challenge for the head and neck surgeon. The aim of the surgery is to achieve anatomical integrity preserving the nasal function. It is complicated to obtain a satisfactory outcome due to the fibrotic areas and low blood supply present around the perforation and the limited tissue available to close it. The numerous techniques employed and the appreciable percentages of failure explain the difficulty in performing this surgical repair [8]. Surgical success for large perforations was approximately 78 %, whereas for small-medium perforations was 93 % [10]. There are a great variety of free grafts and flaps that can be used to repair the defect. Free grafts can be autologous, allogeneic, heterologous or synthetic. The main advantage

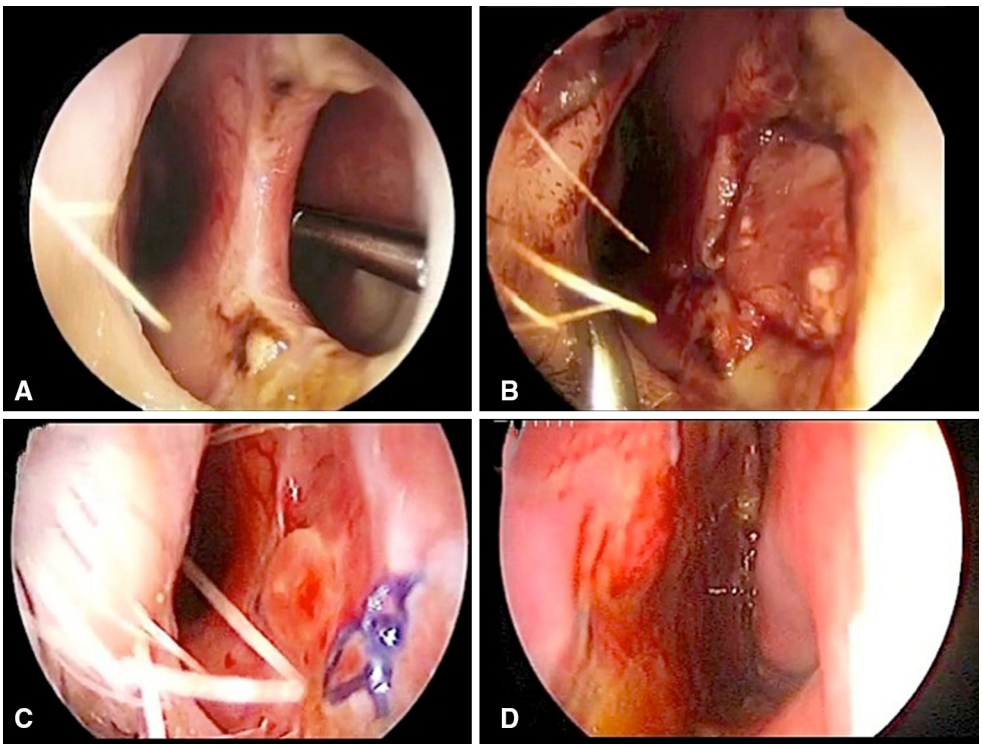

Fig. 3 The figure represents different images using a 0° rigid endoscope. **a** Measure of the perforation with the Cottle elevator. **b** Septal flap covering the perforation from the right nasal fossa. **c** Septal flap covering the perforation from the right nasal fossa at 1 month postoperative. **d** Septal flap covering the perforation from the left nasal fossa at 2 months postoperative

of autologous grafts is the histocompatibility and the low risk of disease transmission. The disadvantage is the limited quantity of tissue that can be employed. The flaps can be free or can be attached to an artery, mostly to a sphenopalatine branch. These mucopericondrical/periosteal advancement flaps are usually designed from the septum, from the nasal floor or from the turbinates. Most authors recommend these pedicle flaps only for small and medium perforations [4]. Lee et al. [11] obtained a closure of 86 % of the perforation with a unilateral advanced nasal mucosal flap in 14 patients and Chhabra et al. [3]. demonstrated a success rate of 85 % using a rotational nasal mucosal flap. The inferior turbinate flap is one of the most common nasal flaps used to repair septal perforations although it seems to provide poor outcomes and it has the problem of the great volume of flap employed [1, 7, 10].

Castelnuovo et al. [2] described an endoscopic repair of anterior septal perforation using a unilateral septal flap in perforations smaller than 2 cm. The anterior septum received branches from the sphenopalatine artery, from the facial artery (superior labial branch) and from the anterior ethmoidal artery (anterior septal branches) [5]. The AEA is a branch of the ophthalmic artery, passing between the superior oblique and the medial rectus muscles. Then, the AEA leaves the orbit through the anterior ethmoidal foramen and it traverses the ethmoidal roof with oblique direction. Then the artery enters the anterior cranial fossa through the lateral lamella of the cribriform plate. It gives off the anterior meningeal artery that enters intracranially and nasal branches, which supply the anterior superior part of the septum and the middle turbinate [5, 13] (Fig. 4). The septal flap described by Castelnuovo is based on this septal branch.

In order to preserve this vascular pedicle the author designed two vertical incisions: one at the level of the posterior border of the perforation and the other 0.5–1 cm posterior to the septal projection of the axilla of the middle turbinate. We managed to obtain a successful result in the closure of the perforation in both our patients, but in the first case we observed a prominent flap in the perforation area that partially obstructed the normal airflow with the consequent nasal discomfort. In order to preserve the artery, we performed a wide pedicle greater than 1 cm posterior to the axilla. The aim of our anatomical analysis was to calculate exactly this distance in a series of cadaver specimens in order to diminish the pedicle and the rotation pivot flap. We showed a median distance of 7.35 mm and none of them was superior to 1 cm. Our results confirm Castelnuovo's statement that the second vertical incision should be made 0.5–1 cm posterior to the septal projection of the axilla, more precisely between 5.5 and 8.7 mm. Thus, with this smaller pedicle we could move the flap more easily and the tissue excess was minimum.

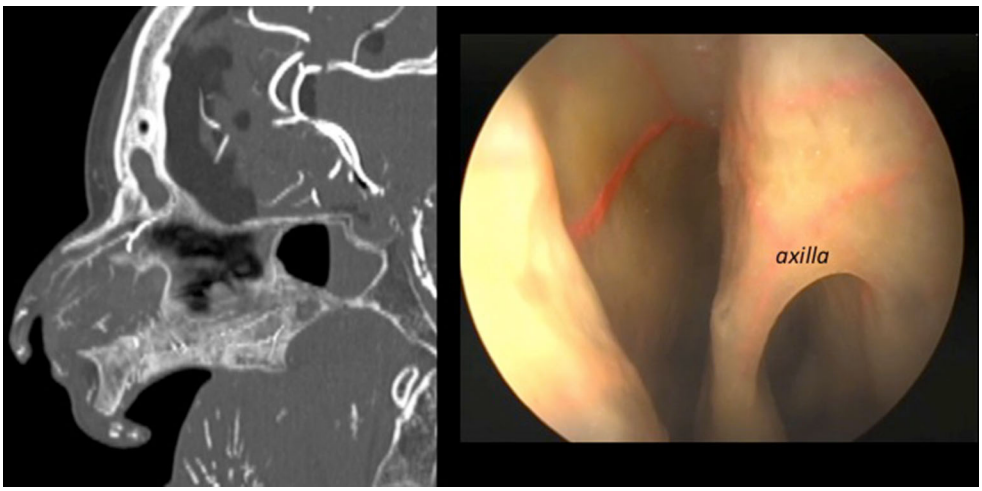

Fig. 4 The CT cadaver and the endoscopic image show the route of the nasal branch of the AEA in the anterior superior part of the septum

Some authors have recommended bilateral mucosal flaps, with or without interposition grafts, with excellent results greater than 90 % [14, 16, 17]. In an extensive review of the literature Kim et al. [6] showed that bilateral flap coverage is superior to unilateral coverage. However, we prefer the unilateral flap in order to preserve the nasal mucosa as much as possible. In addition, we think that with bilateral mucosal flaps the risk of re-perforation can increase due to absence of septum vascularisation.

In our opinion there are some important key points to be considered:

1. We must confirm the integrity of the septum behind the posterior perforation edge, touching this area carefully. We carry out this maneuver in the examination room with a cotton swab. Then we validate it in the surgery room in accordance with our anatomic measures.
2. It is advisable to perform the posterior incision between 5.5 and 8.7 millimetres to conserve the vascular pedicle. It is not necessary to go beyond so we can avoid excessive thickness of the flap.
3. We must extend the flap in the nasal fossa floor until the inferior meatus. This area will be placed in the anterior edge of the perforation.
4. It is important to maintain a bilateral silastic sheet for at least 3 weeks to minimise postoperative scaring.
5. We considerer this unilateral flap only for small perforations of <2 cm due to retraction and suture dehiscence.

Conclusion

We confirm that the unilateral septal flap pedicle by anterior ethmoidal artery may be used between 5.5 and 8.7 mm posterior to the middle turbinate axilla. We can considerer this flap for small and medium perforations.

Compliance with ethical standards

Conflict of interest None.

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