Ligation of anterior ethmoidal artery nasal branch: anatomical-based management of recalcitrant epistaxis

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Rhinology 62: 2, 253 - 255, 2024
https://doi.org/10.4193/Rhin24.317

Received for publication:
July 23, 2024
Accepted: September 7, 2024

Associate Editor:
Ahmad Sedaghat

Dear Editor:
Recurrent epistaxis, despite conservative therapies (i.e. nasal packing or direct vessel coagulation), is generally treated with ligation of the sphenopalatine artery (SPA). Indeed, the rationale behind SPA ligation lies in its ability to disrupt arterial blood supply to the nasal mucosa, thereby reducing the likelihood of recurrent bleeding episodes [(1)]. Nevertheless, in some cases, nosebleeds persist despite appropriate SPA ligation, opening discussion of the anterior ethmoidal artery (AEA) contribution in recalcitrant epistaxis that, for some authors, is up to 28.8% [(2)]. From an anatomical point of view, the AEA leaves the orbital cavity and passes the ethmoidal roof through the ethmoidal canal, before entering inside the anterior cranial fossa via the lateral lamella [(3)]. Endocranially, the AEA gives posterior branches which vascularize the anterior cribriform plate, whereas its many trunk continues anteriorly and divides into two branches: the anterior meningeal branch, and a second vessel that enters inside the nasal fossa through the cribroethmoidal foramen located 2.86 ± 1.93 mm (range, 1-7 mm) [(4)] anteriorly to the first olfactory phylum, giving rise to the so-called nasal branch (NbAEA) [(5)]. Once entered inside the nasal fossa, the NbAEA divides into an external branch (LWbAEA= AEA lateral wall branch), which vascularizes the anterolateral wall of the nasal fossa, and a medial one (SbAEA= AEA septal branch), which vascularizes the anterior portion of the nasal septum (Figure 1). The NbAEA continues then anteriorly few millimeters submucosally and, after 2.43 mm (range 0-7) [(4)], it enters into the bony cribroethmoidal canal located at the level of the nasal bones [(5)]. As a result, in all its pathway from the orbital cavity to the anterior cranial fossa, the AEA does not present any nasal vessels and its main supply to the nasal cavity passes through the NbAEA that, through its branches (LWbAEA, SbAEA and anterior projection of the NbAEA) and anastomosis with the facial/angular artery system, vascularize the major portion of the anterior nasal fossa [(6)]. Between January 2023 and February 2024, 31.204 patients refer-

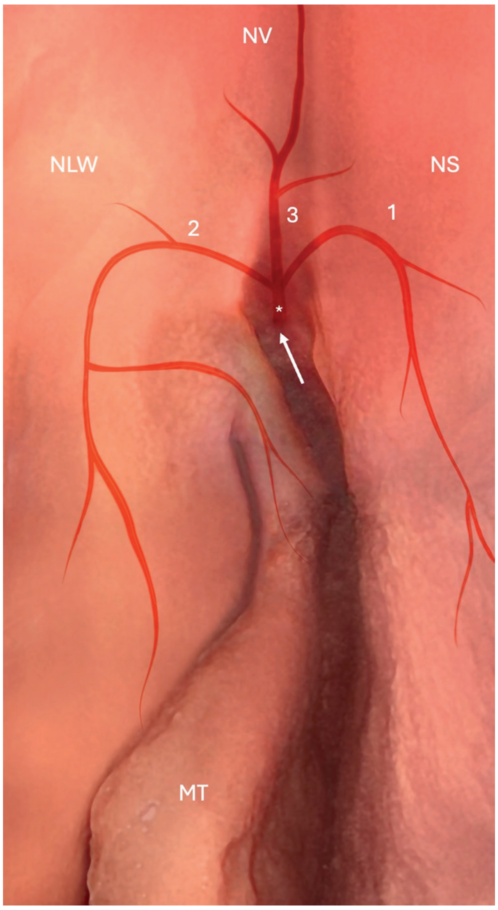

Figure 1. Graphical representation of the endoscopic view of a right nasal fossa with the AEA nasal branches. Specifically, the NbAEA (*) enters inside the nasal fossa via the cribroethmoidal foramen (white arrow) and, after a few millimiters it gives two main branches: the SbAEA (1) and the LWbAEA (2) which vascularize, respectively, the nasal septum and the lateral nasal wall. The NbAEA continues then anteriorly (3) into the cribroethmoidal canal, located at the level of nasal bones, to vascularize the most anterior portion of the nasal roof. LWbAEA= AEA lateral wall branch, MT= middle turbinate, NLW= nasal lateral wall, NS= nasal septum, NV= nasal vault, SbAEA= AEA septal branch.

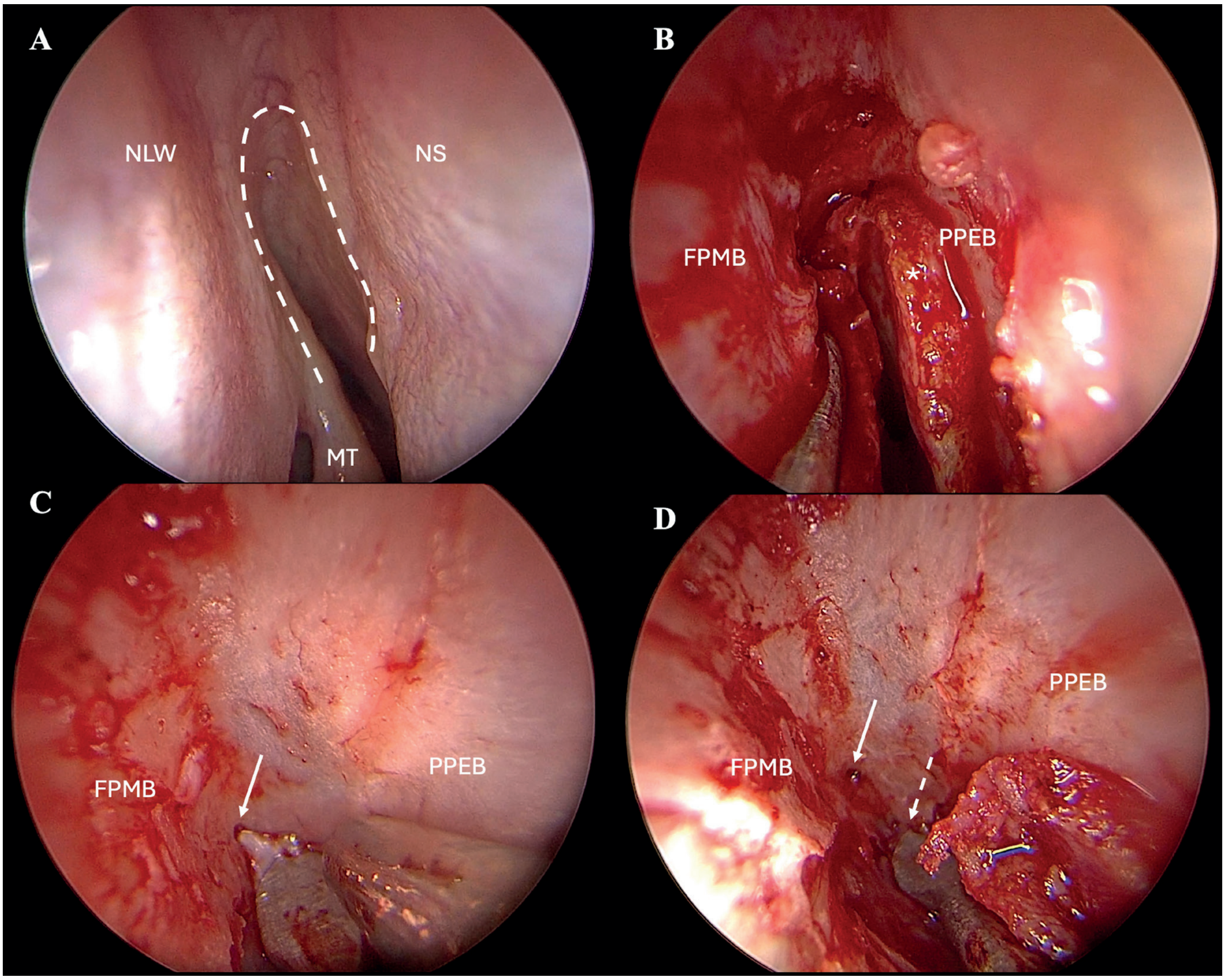

Figure 2. Intra-operative view of a right nasal fossa. Under general anesthesia and using a 30° endoscope, an incision from the head of the middle turbinate to the nasal vault with an additional release incision on the septum is performed. Subperiosteal dissection follows, exposing the proximal end (to the cribriform plate) of the cribroethmoidal canal in which passes the anterior projection of the NbAEA (white arrow). Once exposed, the NbAEA is cauterized and cut; the dissection is then carried out carefully posteriorly until the cribroethmoidal foramen is visualized (dotted white arrow) few millimiters anterior to the first olfactory phylum, where the NbAEA at its origin can be cauterized, thus disrupting the AEA-derived blood supply to the anterior nasal cavity. At the end of the procedure, the previously dissected mucosal flap is repositioned to its original position, and a nasal split is put in place aiming to minimize synechiae and promote proper healing. 1= SbAEA, 2= LWbAEA, 3= anterior projection of the NbAEA that passes into the cribroethmoidal canal. FPMB= frontal process of the maxillary bone, MT= middle turbinate, NLW= nasal lateral wall, NS= nasal septum, PPEB= perpendicular plate of the ethmoid bone.

red to our ENT emergency service of Hopital Lariboisiere (Paris, France), of whom 993 (3.1%) presented for epistaxis and were treated conservatively (i.e nasal meshing) in 942 cases (95.1%). Conversely, 40 patients were surgically treated with SPA ligation with a success rate of 85 % (34/40 patients, Supplementary Material).

Concerns remain about the best surgical approach in epistaxis non-responsive to SPA ligation, since while the main vascular supply of the posterior nasal fossa is interrupted, its anterior portion is still not addressed [7]. Indeed, failure of endoscopic treatment of epistaxis is often related to anterior ethmoidal branches [1]. Traditionally, external approaches (i.e. Lynch incision) have been proposed to urgently ligate the AEA [8], while some authors described its endoscopic endonasal ligation through a complete anterior ethmoidectomy and drilling of the AEA canal [9]. Nevertheless, the first procedure is still valid in the case of AEA retraction into the orbit, whereas the second solution is feasible in experienced centers since it is associated with potential injury of the anterior skull base [9]. To overcome these limitations, we propose an effective (success rate 100%, 6/6 patients non-responsive to SPA ligation) (Figure 2), safe and anatomical-based procedure to disrupt the arterial blood supply of the anterior portion of the nasal fossa through the endoscopic ligation of the NbAEA. This approach goes beyond the direct coagulation of the septal branch of the AEA (Stamm's point), since with the ligation of the NbAEA at its origin (cribroethmoidal foramen) ([3,5]), the arterial vascularization of the lateral wall, septum and roof of the anterior nasal fossa is disrupted. Some would argue that a ligation of the AEA in its canal would guarantee a more effective procedure: however, it would only guarantee an additional hemostasis to the meningeal and the posterior branch to the cribriform plate and no supplementary nasal hemostasis is guaranteed with a collateral additional potential morbidity.

It is noteworthy that, in our cohort, no complications occurred directly related to NbAEA ligation, however, adverse events such as septal perforation, superior nasal synechiae, thermal injury to the olfactory fila and dural transgression at the level of the cribriform plate (rare a priori) should be considered as potential adverse events of this procedure. Larger studies are needed to validate the clinical effectiveness of this anatomical-based surgical technique.

In conclusion, NbAEA ligation is an effective procedure that, associated with SPA ligation, provides optimal hemostatic results in recalcitrant epistaxis. The rationale behind these procedures lies in their ability to disrupt the arterial blood supply to the nasal mucosa in both its anterior (NbAEA) and posterior (SPA) portions.

Acknowledgements

None.

Authorship contribution

AV, AD made substantial contributions to the conception, design and acquisition of data, drafted the article, revised it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; ID, FB, MM, FC, MF, BV, PH made substantial contributions to conception of the data, revised it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of interest

None.

Funding

None.

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This manuscript contains online supplementary material

SUPPLEMENTARY MATERIAL

Materials and methods

This retrospective observational study focuses on patients with refractory epistaxis who underwent NbAEA ligation after an unsuccessful attempt of SPA coagulation, between January 2023 and February 2024. The study was conducted according to the ethical standards established in the 1964 Declaration of Helsinki and revised in 2011 and was approved by the French authorities (CNIL #2225234). Informed consent was obtained from all patients and the study was conducted according to the ethical standards of the Declaration of Helsinki revised in 2011.

All patients examined for epistaxis underwent a rigorous and standardized protocol management based on (Figure 2): 1) preoperative assessment of clinical history (e.g. hypertension, other causes of nasal bleeding) and general physical examination; 2) ambulatorial bilateral endoscopic examination of nasal fossa, with particular attention to the Kisselbach's (anterior epistaxis), Woodruff's (posterior epistaxis), Stam's points and areas of the antero-lateral wall, inferior meatus and at the level of the posterior portion of the nasal septum/nasopharynx; 3) the endoscopic examination was associated with direct coagulation, if the bleeding point was clearly identified, or meshing of the nasal fossa with topical hemostatic agents (e.g. Surgicel); 4) in patients who failed to achieve adequate control of epistaxis with "first-line" measures or in case of epistaxis recurrence within 24 hours, a nasal double balloon packing (e.g. Rapid Rhino 900, Smith & Nephew) was used and the patient was hospitalized with preventive antibiotic therapy. Contrasted computed tomography scan is performed to evaluate the anatomy of the nasal cavity and confirm the absence of other sources of bleeding; 5) after 12-24 hours of nasal double balloon packing, it is gradually deflated. If a resolution of the epistaxis is achieved, the patient is discharged, conversely, if not, a surgical operation is performed.

Surgical procedure

Under general anesthesia and using a 30° endoscope, an exploration of the nasal cavity was performed without using nasal decongestion since this promotes vasoconstriction and might hide the source of the bleeding. If no bleeding point is identified, nasal decongestion is then used with cottonoids soaked in lidocaine naphazoline 5% to reduce bleeding and improve endonasal operative spaces. If a direct source of bleeding is identified, a direct coagulation of the vessel association with a homolateral SPA ligation is performed; conversely, if not, a bilateral SPA ligation is routinely performed. In patients who failed to achieve adequate control of epistaxis despite the absence of visible bleeding point and bilateral SPA coagulation, ligation of the NbAEA was performed (Figure 3). Specifically, the surgical procedure involves making an incision from the head of the middle turbinate to the nasal vault with an additional release incision on the septum. Subperiosteal dissection follows, exposing the NbAEA. Once exposed, this branch is cauterized using bipolar forceps and then cut with endoscopic scissors to achieve hemostasis. After cauterization and cutting, the dissection is carried out carefully until the first olfactory fiber is visualized, ensuring precise coagulation of any additional branch of the AEA. The previously dissected mucosal flap was repositioned to its original position, and a nasal split was put in place aiming to minimize synechiae and promote proper healing. Patients were discharged on the first postoperative day.

Intraoperative findings, including the presence of any additional bleeding sources, were recorded.

Follow-up visits were scheduled at regular intervals (7-30 and 60 days) to assess symptom improvement, recurrence of epistaxis, and any adverse events.

The primary objective of this study was to evaluate the efficacy of NbAEA ligation in controlling refractory epistaxis following an unsuccessful attempt of SPAs ligation.

Results

Among the 31.204 patients referred to the emergency of the ENT department of our hospital between January 2023 and February 2024, 991 patients presented for epistaxis of which 942 (95.1%) were treated with conservative therapies (meshing, direct coagulation of the bleeding point under local anesthesia or nasal double balloon packing) and 11 patients (1.1%) were treated with a bilateral internal maxillary artery radiologic embolization due to major contraindication for surgery or treated with curative anti-coagulants/anti-platelet therapies. In 40 patients (4%), a surgical operation with SPA ligation was necessary with a success rate of 85 % (34/40 patients) (Table 1). Among the 34 patients successfully treated, in 26/34 (76.4%) a bilateral SPA ligation was performed; conversely, 8/40 (23.6%) were treated with an exclusive unilateral SPA ligation.

In the 6/40 patients (15%) resistant to SPA ligation, a second look with NbAEA ligation was performed, with a success rate of 100%. Specifically, in two cases, the procedure was performed intra-operatively as a single step due to persistent bleeding despite SPAs ligation; conversely, in the remaining cases, initial epistaxis control seemed achieved through SPAs ligation, however, in the immediate postoperative, patients experienced epistaxis recurrence thus, the second surgical phase of NbAEA ligation was subsequently carried out.

As postoperative complications, 2 nasal septum perforations occurred in patients who experienced post-surgical epistaxis (septoplasty) and were treated with bilateral SPAs ligation; no complications occurred for the NbAEA ligation procedures.

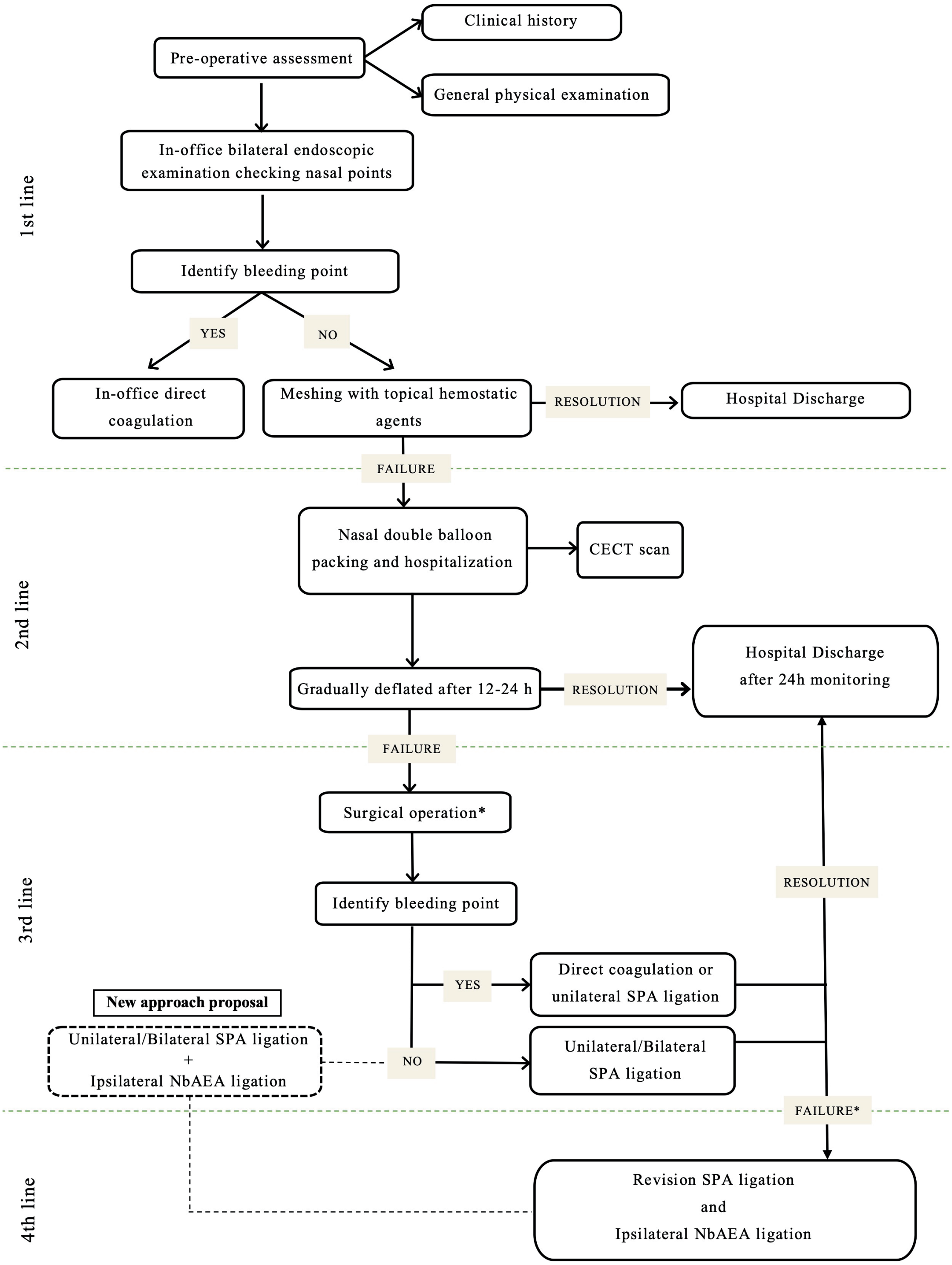

Figure S1. Flowchart showing the management of epistaxis in adulthood. * = The radiologic embolization can always be a solution, specifically if the epistaxis origin is identified at the level of the SPA. Nevertheless, in our cohort, this solution has been reserved for cases treated with curative anti-coagulants/antiplatelet drugs. SPA= sphenopalatine artery, NbAEA= septal branches of the ethmoidal artery, CECT= contrasted enhanced computed tomography.

Supplementary Table 1. Clinical characteristics of the patients treated with SPA and NbAEA ligations.

Surgical approach	N° patients	Sex (M/F)	Age (median and range)	Aetiology	Anti coagu-lant	Lowest Hb (g/dL)	Mean BP (mmHg)	Days between surgeries	Success rate
				PRIMARY SURGICAL APPROACH					
Bilateral SPA ligation	26/34 (76.5%)	19/7	55.5 (22 - 83)	• 19 spontaneous • 2 post-traumatic • 5 post-surgical (1 septal angioma resection and 4 rhino-septoplasty)	7	8.5 (4.5 - 15.1)	134/84	-	85 % (34/40)
Unilateral SPA ligation	8/34 (23.5%)	5/3	55 (32 - 66)	• 3 post-traumatic • 5 post-surgical (3 • ethmoidectomies and 1 middle antrostomy)	2	8 (8.7 - 12.5)	136/90	-	
				SECONDARY SURGICAL APPROACH (intra/peri-operative)					
NbAEA ligation after Bilateral SPA ligation	5/6 (83.3%)	3/2	3/2	• 2 post-traumatic • 3 spontaneous	0	7 (7 – 14,4)	170/100	1 (1-3)	100% (6/6)

Abbreviations: BP = Blood Pressure; BT= Blood transfusions; NbAEA = nasal branch anterior ethmoidal artery; SPA= sphenopalatine artery.