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Review Article

Current Role of Non-Elective Transnasal Endoscopic Surgery: our Experience and Review of The Literature

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Abstract

Background: in the last 30 years Trans-Nasal Endoscopic Surgery (TNES) has emerged as the mainstay of the elective treatment of most pathologies arising from sinonasal cavities. Growing technology and techniques made TNES an essential instrument even in the emergency/urgency scenario.

Materials and Methods: a retrospective cohort analysis was conducted at our tertiary care center including patients who required TNES within 48 hours from their admission at the Emergency Department. Demographic characteristics and surgical outcomes were evaluated for patients treated from 1st January 2016 and 31th December 2020. Moreover, we reviewed the most recent literature about safety and efficacy of non-elective TNES in the management of the commonest otorhinolaryngology emergencies: epistaxis, acute bacterial rhinosinusitis, acute invasive fungal rhinosinusitis, and post-traumatic optic neuropathy.

Results: on the whole, we performed non-elective TNES in 45 patients, with a success and a complication rate of 93.3% and 0.0%, respectively. 11.1% of patients reported long-term sequelae related to their primary disease, in spite of treatment. No deaths were perioperatively reported. 52 studies about non-elective TNES were included in the present paper, each encompassing one single disease.

Conclusion: the specific competences acquired by otorhinolaryngologists made TNES a safe and efficacious procedure even in the treatment of non-elective sinonasal diseases. The importance of a well-trained multidisciplinary team came to light for a prompt and correct management of sinonasal conditions that are barely rare but potentially sight- and life-threatening.

Keywords: Head and neck surgery; Sinonasal disease; Surgical complications; Surgical emergencies; Transnasal endoscopic surgery

Introduction

Albeit the potential of the trans-nasal route was already known by ancient Egyptians, who used to remove the brain of deceased Pharaohs from the nostrils in mummification rituals [1,2], and by Hippocrates, who gave the first indications for nasal polyps treatment [3], Transnasal Endoscopic Surgery (TNES) has developed very slowly throughout the centuries. The introduction in the second half of the XX century of the fiber optics and rod-lens endoscope, designed by Harold Hopkins, gave a fundamental stimulus to the spreading of the TNES and other fields of endoscopic surgery [4,5]. Subsequent studies conducted by Messerklinger, Stammberger, and Draf laid the foundations of modern endoscopic sinus surgery as we know it [6-8]. From that

moment on, TNES has increasingly emerged as a cornerstone in the elective treatment of the vast majority of sinonasal conditions: for instance, the development of technology and surgical techniques have made possible the complete transnasal excision of sinonasal malignancies extending intraorbitally and/or intracranially, as well as the treatment of primary neurosurgical and ophthalmological pathologies [9]. Even in the emergency/urgency setting, TNES is now the preferred choice for the treatment of many sight- and life-threatening conditions arising from sinonasal cavities. The aim of this paper is to present our experience and to critically review the most recent literature about the efficacy and safety of non-elective TNES.

Materials and Methods

Literature Search and Studies Selection

We conducted a systematic search of the most recent literature regarding the clinical results of non-elective TNES in the management of the most common sinonasal/orbital condition needing surgery within 48 hours from diagnosis. The search encompassed the last 5-year period and was conducted using PubMed. Studies were identified independently by two authors (PO and LGL) using the following combination of keywords: "rhinosinusitis and orbital complications, rhinosinusitis and intracranial complications, rhinosinusitis and subdural abscess, rhinosinusitis and subdural empyema, rhinosinusitis and brain abscess, rhinosinusitis and meningitis, rhinosinusitis and cellulitis, rhinosinusitis and subperiosteal abscess, rhinosinusitis and orbital abscess, rhinosinusitis and septic cavernous sinus thrombosis, acute invasive fungal rhinosinusitis, orbital hematoma and endoscopy, orbital hematoma and endoscopic, orbital hemorrhage and endoscopy, orbital hemorrhage and endoscopic, transnasal endoscopic optic canal decompression, epistaxis, epistaxis and endoscopy, epistaxis and endoscopic, sphenopalatine artery and ligation, sphenopalatine artery and electrocautery." Studies to be included were selected following the PRISMA 4-phase flow diagram [10]. All studies regarding adult patients receiving non-elective TNES for sinonasal, orbital, or anterior skull base conditions, within 48h from the hospital admission were screened for eligibility by reading the abstracts after removing duplicates. Full texts were then retrieved and evaluated separately by the two authors. We decided to exclude small case series (< 5 patients) and single case reports, articles not written in English, and studies with entirely pediatric cohorts, as well as studies focusing exclusively on ear/lateral skull base conditions. Separate spreadsheets for each treated condition (Google Sheets, Google Inc, Mountain View, CA 94043, USA) were used in order to report the following data: author, year, number of enrolled patients, treatment, success rate, complications rate, long-term sequelae, and mean hospital length of stay.

Medical Charts Review and Patients Selection

After the approval of our Institutional ethics committee, we revised the clinical charts of the Department of our tertiary care center in the period from January 1, 2016, to December 31, 2020. We selected any patient being admitted for an emergency/urgency surgery (i.e, within 48 h) and, in particular, those who were treated by an endoscopic-assisted transnasal approach. We excluded emergency/urgency conditions that were managed with medical treatment alone, with purely open approaches, or with outpatient procedures. Patients who met inclusion criteria were subsequently divided into four different categories according to their own medical issue: epistaxis, orbital and intracranial complications of acute bacterial rhinosinusitis, orbital and intracranial complications of acute invasive fungal rhinosinusitis, post-traumatic optic neuropathy. For each patient, the following data were retrieved: age, gender, risk factors, treatment modalities, outcomes (success rate, postoperative complications, perioperative mortality, need for reintervention), blood transfusion, length of hospital stay, and follow-up duration. Complications of TNES were stratified according to the 3-grade system proposed by Siedek et al. into minor, major and serious complications [11].

Results

Literature Findings

A primary literature search including the period coming from 2016 to 2020 retrieved 1050 studies: 341 about uncontrollable epistaxis, 195 about orbital and intracranial complications of ABRS, 67 about AIFR, and 447 about PTON. After applying the selection criteria, 20 studies about epistaxis, 10 about orbital and intracranial complications of ABRS and 12 about AIFR, and 10 about PTON were included in the present work, with an overall number of 52 papers for a total of 3,054 patients receiving non-elective TNES.

- **Epistaxis**

Among the 20 studies included, 15 authors discuss the use of sphenopalatine artery ligation (SPAL) technique [12-27]. One author compared SPAL to sphenopalatine foramen electrocauterization (SPFEC) [25] and two authors compared microwave ablation of the sphenopalatine artery (SPAMWA) to SPFEC and SPAL, respectively [28,29]. Finally, two paper discussed about pros and cons of SPAL and endovascular sphenopalatine artery embolization (ESPAE) [30,31]. On the whole, 828 patients were treated with TNES for an intractable epistaxis and 46 with ESPAE (Table 1). The most common technique was SPAL, which was performed for 745 patients (90.0%), followed by SPFEC (83 patients, 10.0%), and SPAMWA (56 patients, 5.9%). 30/570 patients (5.3%) needed a second intervention because of recurrence, while 1 patient died because of bilateral posterior epistaxis [13]. 11/665 patients (1.7%)

had a postoperative major complication, the most disabling of which were permanent diplopia (2/11) and unilateral blindness (1/11).

Author	Year	Study type	Treatment	Patients n°	Success %	Complications n° (%)	Reintervention, n° (%)	Mean hospital stay (days n°)
Yu L et al.	2020	retrospective	SPAL	47	100	6 (12.8): 3 crusting, 2 upper lip numbness, 1 pus	nr	nr
Tessler I et al	2020	retrospective	SPAL	54	100	0	0	nr
Chitsuthipakorn W et al.	2020	retrospective	SPAL *vs* SPFEC	34 (10 vs 24)	97.1 (90% vs 100%)	4 (11.8 - 10 *vs* 12.5): 4 palatal numbness	0	nr
Piastro K et al	2020	retrospective	SPAL	62	96.8	1 (1.6): death, due to bilateral posterior bleeding	0	nr
Lou ZC	2019	retrospective	MWA *vs* SPFEC	111 (52 *vs* 59)	96.2 *vs* 93.2	0	2 *vs* 4 (3.8 *vs* 6.8)	3
Hey SY et al.	2019	retrospective	SPAL	65	92.3	1 (1.5): 1 TSS	5 (7.7)	
Marin E et al	2019	retrospective	SPA and EA ligation	60 (45 + 15)	79.5%	nr	nr	nr
Hervochon R et al	2018	retrospective	SPAL	83	84.4	0	13 (15.7)	nr
de Bonnecaze G et al	2018	retrospective	SPAL *vs* embolization	80 (39 *vs* 41)	74 *vs* 76	2 *vs* 7 (5.1 *vs* 17.1): 1 STN, 1 diplopia *vs* 5 STN, 1 blindness, 1 diplopia	nr	6 *vs* 7
Carey B et al	2018	retrospective	SPAL *vs* embolization	12 (7 *vs* 5)	nr	nr	nr	8.1
Odat H et al	2016	retrospective	SPAL	16	100	0	0	3.7
Dutta M et al	2016	case-control	SPAL	38	76.3	nr	nr	nr
Erylmaz A et al	2016	retrospective	SPAL *vs* MWA	5 (1 + 4)	100	nr	0	nr
Zou Y et al	2016	retrospective	SPAL	38	100	2 (5.3): 2 TSS	0	nr

McDermott AM et al	2016	retrospective	SPAL	45	87	0	2 (4.4)	5.4
Iimura J et al	2016	retrospective	SPAL	6	100	nr	nr	/
Yung M et al	2016	retrospective	SPAL	21	76	nr	1 (4.8)	nr
Vosler OS	2016	prospective	SPAL	25	nr	nr	nr	3.7
Saraceni Neto P et al	2016	double-blinded randomized	SPAL	42	83.3	nr	nr	nr
Ismi O et al	2016	retrospective	SPAL	30	90	0	3 (10.0)	nr

List of abbreviations: SPA sphenopalatine artery, SPF sphenopalatine foramen, EA anterior ethmoidal artery, SPAL sphenopalatine artery ligation, SPFEC sphenopalatine foramen electrocautery, MWA microwave ablation, nr not reported, STN soft tissue necrosis, TSS turbino-septal synechiae

Table 1: list of included articles about epistaxis.

- **ABRS**

Studies about complications from ABRS included 309 patients that, according to the five-tiered Chandler's classification [32], were divided as follows: 114 preseptal cellulitis (stage I), 46 postseptal cellulitis (stage II), 74 subperiosteal orbital abscesses (SPOA, stage III), 20 orbital abscesses (stage IV) and 49 cavernous sinus thrombophlebitis (CST, stage V) [33-42]. In addition, 19 patients (8.41%) presented at the otorhinolaryngology department with a concomitant intracranial complication: 10 cerebral abscesses, 4 cerebral infarctions, 2 epidural abscesses, 2 subdural empyemas, and 1 case of meningitis (Table 2). On the whole, 72 patients (31.9%) underwent TNES for the drainage of mucopurulent sinuses, while 11 patients (11.9%) required a combined endoscopic/external approach. Recurrence was observed in 6/195 cases (3.1%), while no major surgical complications were reported. Mortality rate amounted to 0.9% (2/226, Table 2).

Author	Year	Patients n°	Treatment modalities	Surgical Complications, n(%); recurrence, n(%)	Sequelae, n(%); Mortality, n(%)	Mean hospital stay (days)
Sansa-Perna A et al	2020	21 OC (I 9; II 2; III 9; IV 1); 2 concomitant IC	I-II: 100% AB; III: 22.2% AB, 44.4% AB+TNES; 33.3% AB+TNES+EA; IV: 100% AB+TNES; IC: 50% AB+TNES; 50% AB+NS	0(0); 0(0)	0(0); 0(0)	nr
Mahalingam S et al	2020	26 (I-II: 21; III: 2; IV: 3; IC: 4)	I-II: 3.8% AB+TNES; 96.2% AB; III: 50% AB, 50% AB+EA; IV: 100% AB+TNES; IC: 100% AB+TNES+NS	0(0); 3(2.9)	0(0); 0(0)	nr

Hsu CW et al	2019	14 OC (V 14); 5 concomitant IC	OC: 92.9% AB+TNES; 7.1% AB; IC 100% AB+TNES+NS	0(0); 0(0)	8(57.1) [4 hemiparesis, 4 ophthalmoplegia, 3 VL; 2 HL; 2 facial palsy]; 1(7.1) [neck infection]	nr
El Mograbi A et al	2019	70 OC (I 43, II 16, III 8, IV 2, V 1); 2 concomitant IC	OC: 85% AB; 10% AB+TNES; 5% AB+TNES+EA; IC: 100% AB+TNES	0(0); 3(4.0)	0(0); 0(0)	8.7
Tachibana T et al	2019	21 OC (I 4, II 8, III 9)	I: 100% AB II: 87.5% AB; 12.5% AB+TNES III: 55.6% AB; 33.3% AB+TNES; 11.1% AB+EA	0(0); 0(0)	0(0); 0(0)	8.1
Ismi O et al	2019	25 OC (II 11, III 11, IV 3)	78.0% AB+TNES; 12.0% AB+TNES+EA	nr	3(12) [blindness]; 0(0)	nr
Gavriel H et al	2018	37 OC (I 18; III 19)	I: 100% AB III: 63.2% AB, 31.6% AB+TNES, 5.3% AB+TNES+EA	0(0); 0(0)	0(0); 0(0)	5.4
van der Poel NA et al	2018	6 OC (V 6); 1 concomitant IC	V: 100% AB+TNES; IC: 100% AB+TNES+NS	0(0); 0(0)	0(0); 1(16.7)	9.7
Branson SV et al	2018	6 OC (V 6); 5 concomitant IC	OC: 33.3% AB+LMWH; 16.7% AB+LMWH+TNES; 50.0% AB+LMWH+EA; IC: 20.0% AB+NS	nr	4(66.7) [1 blindness, 3 ophthalmoplegia]; 0(0)	21.0
Chang YS et al	2017	83 OC (I 39, II 8, III 16, IV 8, V 12)	44.6% AB; 45.8% AB+TNES; 9.6% AB+EA	nr	5(6.) [5 blindness]; 2(2.4)	13.8

List of abbreviations: OC: orbital complications; IC: intracranial complications; I-V: Chandler's stage; PPT Pott's puffy tumor; FOM frontal osteomyelitis; AB: antibiotics; LMWH: low molecular weight heparin; TNES: transnasal endoscopic surgery; NS: neurosurgery; EA: external approach; VL: visual loss; HL: hearing loss; nr: not reported

Table 2: list of included articles about acute bacterial rhinosinusitis.

- **AIFR**

Studies about AIFR included 351 patients, of whom only 5 did not have a primary or secondary immunodeficiency at the time of hospital admission (Table 3) [43-48]. 198 patients (56.4%) were treated with TNES, 5 (1.4%) with an open external approach, and 126 (35.9%) with a combination of TNES and open techniques. 85/186 patients (45.7%) need at least one revision surgery, while no surgical complications were reported. 114 patients (32.5%) died because of uncontrolled infection, while no intraoperative death was reported (Table 3). Blindness was the most frequent long-term sequelae [49-53].

Author	**Year**		**Comorbidities %**	**Treatment %**	**Surgical Complications, n(%); recurrence, n(%)**	**Sequelae n°(%); Perioperative mortality n°(%)**	**Mean hospital stay (days)**

Nyunt TPK et al	2020	56	DM 100	95.4 M + TNES; 4.6 TNES	nr ; 32 (57.1)	nr ; 14 (25.0)	nr
Vengerovich G et al	2020	34	DM 50; ISM 47.1; HM 35.3; SOT 23.5; SM 8.8; none 2.9	64.7 M+TNES; 11.8 M+TNES+EA; 11.8 M+EA; 8.8 M; 2.9 none; 20.6 EO	nr; nr	7(20.6) OE; 21(61.8) *4(11.8) patients lost on FU	35.1
Lagos A et al	2020	22	HM 84.4; DM 9.4; SOT 6.3; HIV 3.1	nr	nr; nr	nr; 15(46.9)	nr
Nam SH et al	2020	50	DM 56; HM 30; SOT 12; SM 10; none 8	62 M+TNES; 38 M+TNES+EA;	0(0); 26(52)	9(18.0) OE; 7(14.0)	nr
Shanbag R et al	2019	8	DM 75; anemia 25; ISM 12.5	37.5 M+TNES; 62.5 M+TNES+EA	nr; nr	0(0); 0(0)	47.4
Burton BN et al	2018	979	HD 42.9; DM 37.9; ID 6.2; SOT 5.3	/	nr; nr	nr; 155(15.8)	17
Wu PW et al	2018	21	DM 100; 14.3 SM; 4.8 HM; 4.8 ISM	90.5 M+TNES; 9.5 M+TNES+EA	nr; 12(57)	5(23.8) VL, 1(4.7) oronasal fistula, 2(9.5) OE; 8(38.1)	nr
Fenandez IJ et al	2018	19	HM 89.5; DM 15.8	84.2 M+TNES; 15.8 M+TNES+EA	nr; nr	2(1.5) OE; 5(26.3)	nr
Roxbury CR et al	2017	54	HM/SM 79.6; DM 25.9: HIV 7.4	13 M; 87 M+TNES	nr; nr	1(1.9) OE; 16(29.6)	nr
Ergun O et al	2017	18	HM 63.1; ISM 42; DM 15.3	100 M+TNES	nr; 6(33.3)	nr; 11(61.1)	nr
Bakhshaee M et al	2016	18	DM 50; HM 44.4; ISM 11.1	83.3 M+TNES; 5.6 M+E; 11.1 M+TNES+EA	nr; nr	4(22.2) VL, 2(11.1) OE, 1 FP(5.6); 3(16.7)	nr
Payne SY et al	2016	41	HM 97.5; ISM 2.5	90.2 M+TNES; 9.8 M	nr; 9(22.0)	nr; 10(24.3)	nr
Pagella F et al	2016	10	ISM 80; HM 20	80 M+TNES; 20 M	nr; nr	0(0); 4(40)	nr

List of abbreviations: AIFR acute invasive fungal rhinosinusitis; DM diabetes mellitus; ISM immunosuppressant medications; HM hematological malignancy; SOT solid organ transplant; SM solid malignancy; HIV human immunodeficiency virus; HD hematological dysfunction; ID immunodeficiency; M medical therapy; ESS endoscopic sinus surgery; E external approach; OE orbital exenteration; VL visual loss; FU follow-up.

Table 3: list of included articles about acute invasive fungal rhinosinusitis.

- **PTON**

10 studies about PTON were included with a total number of 556 patients (Table 4) [54-64]. All of them were treated with a transnasal optic nerve decompression (TEOCD) but only 188/332 (56.6%) reported any improvement in Best Corrected Visual Acuity (BCVA) at the end of the procedure. Intraoperative complications included 22 Cerebrospinal Fluid Fistulas (4.7%) (CSF), and 5 cavernous sinus hemorrhages (0.9%), while no fatality was registered.

Author	Year	Patients n°	Treatment modality %	Days from diagnosis to surgery (mean)	Patients with improvement of Visual Acuity, n (%)	Complications n°(%); Mortality n°(%)	Mean Hospital Stay (n° days)
Lin J et al	2020	72	100 TEOCD	6.1	39 (54.2) [mean +0.27]	0(0); 0(0)	nr
Gupta D	2018	20	100 TEOCD	75% within 72 h	16 (80)	0(0); 0(0)	nr
Li J et al	2020	22	1oo TEOCD	1 (4.5) < 7 days; 21 (95.5) > 7 days	13 (59.1)	1 CSF (4.6); 0(0)	
Sun J et al	2020	16	100 TEOCD	21.9 (3 < 10 days)	3 (18.8)	nr	nr
Yu B et al	2020	41	100 TEOCD (etm)	< 3	31 (73.2) (vs 46.9 with steroids)	4 CSF (9.8); 0(0)	nr
Zhou MG et al	2020	31	100 TEOCD (etm)	after steroid therapy	19 (61.3)	4 CSF (12.9); 0(0)	nr
Ma YJ et al	2018	224	100 TEOCD	30.1		11 CSF (4.9) + 4 CSH (1.8) = 15 (6.7); 0(0)	nr
He ZH et al	2016	11	100 TEOCD	8 < 14 days	5 (45.5)	2 CSF (18.2); 0(0)	nr
Yu B et al	2016	96	100 TEOCD	33 (34.4%) < 3 days	45 (46.9)	4 CSF (4.2) + 1 CSH (1.0) = 5 (5.2); 0(0)	nr
Emanuelli E et al	2015	26	100 TEOCD	62% < 1 day; 19% < 2 days	17 (65.0)	0(0); 0(0)	nr

List of abbreviations: TEOCD transnasal endoscopic optic canal decompression; nr not reported; CSF cerebrospinal fluid; CSH cavernous sinus hemorrhage

Table 4: list of included articles about post-traumatic optic neuropathy.

Institutional Experience

Based on the aforementioned selection criteria from January 1, 2016, to December 31, 2020, we have identified 190 patients necessitating urgent otolaryngological procedures within 48 hours from the ED admission. Among them, we selected the 45 (23.6%) patients who were treated with TNES. In particular, we identified 24 intractable epistaxis, 17 orbital and intracranial complications from ABRS, 2 orbital and intracranial complications from AIFR, and 2 post-traumatic optic neuropathy. 21 patients were male and 24 were female, while the mean age was 57.7 years. Other demographic characteristics of the patients included in the present study are reported in Table 5.

	Overall	Epistaxis	ABRS	AIFR	PTON
Patients, N°	45	24	17	2	2
Sex					
• Male	21	11	9	0	1
• Female	24	13	8	2	1
Mean Age (years)	57.7	60.1	54.4	71.0	45.0
Risk factors					
• AHT	14	8	5	1	0
• Asthma	3	0	2	1	0
• DM2	2	1	0	1	0
• Immunodeficiency	2	0	1	1	0
• Pregnancy	1	1	0	0	0
• OAC	5	4	1	0	0
• CRSwNP or CRSsNP	11	0	8 + 3	0	0
• Previous sinonasal surgery	6	1	5	0	0
• Professional exposure	1	1	0	0	0
Smoking history, N(%)					
• Current	10	5	4	1	0
• Former	5	3	2	0	0
Previous similar episodes, N(%)					
• None	25	9	15	1	0
• 1	3	1	1	1	0
• > 1	15	14	1	0	0
Affected side, N(%)					
• Right	25 (55.6)	12 (50.0)	10 (58.8)	1 (50.0)	2 (100.0)
• Left	20 (44.4)	12 (50.0)	7 (41.2)	1 (50.0)	0 (0.0)
Need for Blood transfusion	6 (13.3)	6 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)

Surgery, N(%) • TNES • TNES + Open Approach	41 (91.1) 4 (8.9)	24 (100.0) 0 (0.0)	13 (76.5) 4 (23.5)	2 (100.0) 0 (0.0)	2 (100.0) 0 (0.0)
Need for reintervention, N(%)	3 (6.7)	2 (9.1)	1	0 (0.0)	0 (0.0)
Complications, N(%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Intensive Care Unit, N°(%)	5 (11.1)	1 (4.2)	1 (5.9)	1 (50.0)	1 (50.0)
Long Term Sequelae, N(%),	4 (8.9)	0 (0.0)	2, 1 hemiplegia, 1 unilateral blindness (11.8)	1, 1 orbital exenteration (50.0)	1 (50.0)
Mortality, N(%) • Perioperative • Follow-up	0 (0.0) 2 (4.4)	0 (0.0) 1 (4.2)	0 (0.0) 1 (5,9)	0 (0.0) 0 (0.0)	0 (0.0) 0 (0.0)
Length of Hospital Stay (days)	8.5	5.7	10.9	22.0	7.5
Mean Follow-up (months)	23.1	25.2	20.6	13	30

Table 5: main demographic and clinical characteristics of enrolled patients.

- **Epistaxis**

We identified 24 patients who were surgically treated for intractable epistaxis; 11 of them were males and 13 females with a mean age of 60.1 years. 6/24 patients (25.0%) required a blood transfusion because of a Hb value < 7g/dL on ED admission [65]. Arterial hypertension was the most common risk factor (33.3%) for epistaxis, followed by oral anticoagulant therapy (16.7%). The only patient admitted to ICU had both underlying conditions. All of the bleeding arteries were treated with the electrocautery technique, and in particular, we treated 21 Sphenopalatine Arteries (SPA) (concomitantly with the Anterior Ethmoidal Artery (AEA) in two cases and with the Posterior Ethmoidal Artery (PEA) in one case), 2 capillary hemangiomas of the middle turbinate and 1 diffuse hemorrhage from a septal perforation. 22/24 patients (91.7%) were successfully treated with electrocautery; in addition, two hypervascularized lesions originating from the middle turbinate were completely excised, with one of them also requiring preoperative ESPAE. Conversely, 2 patients required a revision surgery: the former for the electrocauterization of his ipsilateral AEA, the latter for the embolization, and the following electrocauterization, of his ipsilateral infraorbital artery (he already underwent an ipsilateral ESPAE 4 years before at another ENT department). No complications related to the endovascular procedure were reported. The only postsurgical complication was a turbino-septal synechia, while no major complications or death related to epistaxis or surgery were observed during a mean follow-up period of 25.2 months. One male patient died of SARS-CoV2 pneumonia during follow-up.

- **ABRS**

From our registers, we identified 17 patients suffering from an orbital or an intracranial complication of ABRS that underwent non-elective TNES. 9 patients were male and 8 were female, with a mean age of 54.4 years. 11 patients (64.7%) had a previous history of chronic rhinosinusitis, 3 sine nasal polyps (CRSsNP), and 8 with nasal polyps (CRSwNP), of whom 5 with at least 1 previous functional endoscopic sinus surgery operation. According to Chandler's classification, we identified 1 periorbital cellulitis (Chandler I); 7 orbital cellulitis (Chandler II), 8 of whom were associated with massive sinonasal polyposis; 3 subperiosteal abscesses (Chandler III), 2 of whom were associated with a Pott's puffy tumor; 3 orbital abscesses (Chandler IV). Moreover, we found two CST (Chandler V) with neurologic signs and symptoms and one intracranial manifestation of ABRS, that was a fronto-temporal subdural empyema associated with a meningoencephalitis). Two patients admitted for an orbital cellulitis developed an ipsilateral endophthalmitis and ipsilateral dacryocystitis, respectively. BCVA, intraocular pressure, extraocular movements, fundus oculi and pupillary reflex of all the patients were evaluated by an ophthalmologist. On the other hand, 3 patients with ICs were examined by a neurosurgeon. 15 patients (83.33%) were successfully treated with a purely endoscopic transnasal approach; on the contrary, 3 of them required a combined TNES/open

approach because of a concomitant frontal sinus mucocele, extension of the primary pathological process to the ipsilateral lacrimal gland, and simultaneous right fronto-temporal subdural empyema, respectively. Furthermore, the younger patient affected by cavernous sinus thrombophlebitis obtained trans-tympanic tubes for a bilateral otitis media with effusion, probably provoked by his underlying nasopharyngeal adenoid cystic carcinoma. All patients received a postoperative EV broad-spectrum antibiotics regimen that consisted of Vancomycin 1 g TID and piperacillin-tazobactam 4.5 g QID, associated with high-dose methylprednisolone. Two emblematic cases are represented in Figure 1. Actually, patients with Chandler stage I or II were addressed to surgery just in case of missing clinical improvement after a 24-48 hour-lasting intravenous antibiotic therapy. No major intraoperative or postoperative complications were reported during a mean follow-up period of 20.6 months. We only observed two long-term sequelae which may be directly related to ABRS: one patients developed unilateral blindness, but she already had a severe endophthalmitis at the moment of ED admission; analogously, hemiplegia occurred in a male patient who referred to ED 9 days after symptoms onset and whose CT scan already showed a vast ischemic-like compromission of frontal and temporal lobes and an ipsilateral subdural empyema at ED admission (Figure 2). One patient with Chandler V disease died two months after TNES, because of the progression of her primary nasopharyngeal adenoid cystic carcinoma. The mean length of hospital stay was 10.9 days, including one Intensive Care Unit (ICU) admission for the patient with subdural empyema.

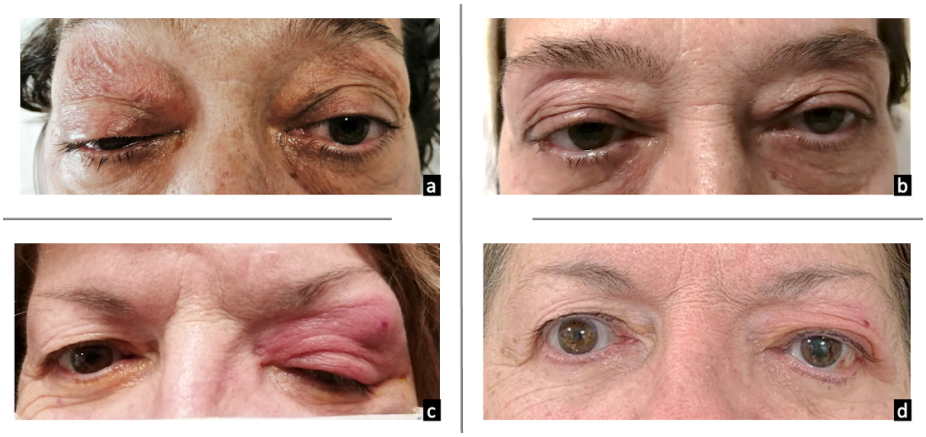

Figure 1: a - b) clinical appearance of a patient affected by orbital cellulitis on the day of emergency department admission and on the 10th post-operatory day, respectively; **c - d)** clinical appearance of a patient affected by cavernous sinus thrombophlebitis on the day of admission and after ten days, respectively.

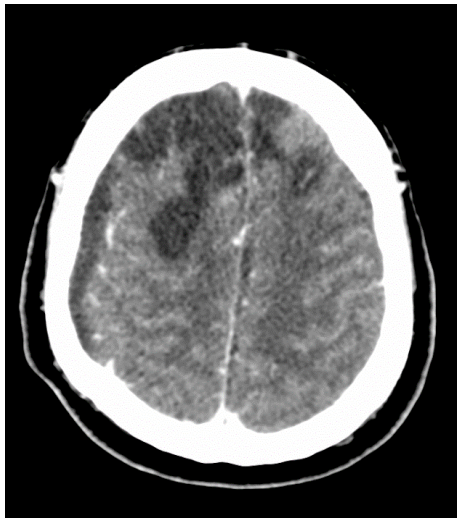

Figure 2: Radiological findings of a patient affected by ABRS and a concomitant intracranial complication, namely a subdural empyema and a meningoencephalitis.

- **AIFR**

We treated two patients affected with acute invasive fungal RS; they both were female with a mean age of 71.0 years. The older one was a 90-year-old woman with a history of allergic asthma, heavy smoking, and alcoholism that referred to the ophthalmologic ED because of ocular pain and visual loss. The younger one was a 52-year-old female with a type 2 diabetes mellitus and a recent history of unilateral kidney transplantation followed by immunosuppressive therapy, complaining of nasal discharge, palpebral swelling and facial pain; in addition, she tested positive for SARS-CoV-2 infection on an RT-PCR obtained at the moment of ED admission. Prompt intravenous antibiotic and antimycotic therapy with ceftazidime 2 g TID + vancomycin 750 mg BID and fluconazole 800 mg SID was administered and TNES was performed in both patients in order to remove all the necrotic tissue; additionally, an orbital exenteration was necessary for the older patient because of concomitant aggressive endophthalmitis that provoked a complete loss of VA in the affected eye. No major surgery-related complications and disease-related sequelae were reported during a mean follow-up period of 13.0 months. The mean length of hospital stay was 22.0 days, including an ICU admission for the older patient and an Infectious Disease Department admission for the patient affected by COVID-19.

- **PTON**

In the study period, we have managed two cases of optic neuropathy following a car accident. The sex ratio was 1:1, with a mean age of 45.0 years. At the time of admission, patients BCVA was registered by ophthalmologists as “hand motion” for the male patient and as “No Light Perception” for the female patient, respectively. Both received a transnasal endoscopic decompression of the affected orbital cavity, together with high-dose methylprednisolone and a prophylactic intravenous antibiotic therapy. No major surgical complications were reported. One month after hospital discharge, the male patient developed a retinal detachment in the same eye and underwent scleral buckle surgery and vitrectomy. Unfortunately, unilateral blindness was not spared in both patients. Mean hospital stay was 7.5 days.

Discussion

Growing technology and experience in endoscopic surgery enabled TNES to progressively become the first-choice technique for both elective and emergent treatment of the vast majority of sinonasal pathologies. Nowadays, many ENT emergencies can be managed with non-invasive methods, such as pharyngo-laryngeal foreign bodies, intractable epistaxis, orbital and cerebral complications from acute mycotic and bacterial rhinosinusitis, retrobulbar hemorrhage with or without optic nerve suffering, etc. Our literature search found many case series illustrating pros and cons of non-elective TNES in the management of one singular disease, and our reported 93.3% success rate with no surgery-related complications is in line with the literature.

Epistaxis is the most common otorhinolaryngological cause of ED admission, but fortunately only 1.6 in 10,000 will require hospitalization [66]. Various strategies to arrest an epistaxis that provoke hemodynamic instability or that keep on bleeding despite first-line measures have been developed: SPAL, SPFEC, SPAMWA, and ESPAE. SPAL is the preferred one by the vast majority of authors, reporting success rates ranging from 76.0 to 100.0%. 8/12 authors reported surgical complications, including only 3 cases of TSS (1.5 - 5.3%) and one death due to a bilateral posterior epistaxis. 6 authors [17,24,26,27,30,31] did not report any complication and we may speculate that authors did not discuss about surgical side effects just because they did not have any surgical side effects, furtherly highlighting safety of SPAL. Similarly, when comparing SPAL with ESPAE, De Bonnecaze et al. [30] reported a higher major complication rate for terminal maxillary artery branches embolization (17.1 vs 5.1) with overlapping success rates. Moreover, endovascular procedures are burdened by longer mean hospital stay and higher costs [67]. More recently, SPFEC and SPAMWA have been widely introduced to control nosebleeding. Both have an excellent success rate (91.5 - 100%) and only minor complications have been reported, such as nasal crusting and temporary palatal or upper lip numbness (3.8 - 12.8%) [24,25,28]. Differently, Marin et al. [26] reported an 82.0% success rate, probably because they also include anterior and posterior ethmoidal arteries bleeding, which are historically known to be more arduous to be arrested.

ABRS is an inflammatory disease of the nose and the paranasal sinuses whose rare complications may involve orbital and/or intracranial contents, and they may be so severe as to inflict long-life disabling sequelae and even bring death [68-71]. In the study of Chang et al. [42], 36.1% of patients had a history of chronic rhinosinusitis (CRS), which is thought to be a favorable factor for recurrent RS exacerbation and severe ocular (OC) and or intracranial complications (IC). In our series, CRS was the most frequent underlying condition, as 11 out of 17 patients (64.7%) with OC or IC had a history of CRS, 8 of whom with nasal polyps. Mucus and polyps may close natural ostia for a long time, promoting ciliar impairment and sinusal bacterial superinfection; moreover, chronic polyposis may thicken bone walls and/or provoke discontinuities in the bone walls, that may facilitate bacteria migration through orbital and cranial contents. If an OC is suspected, blood exams and CT scan are mandatory, as well as an ophthalmological consultation to examine ocular alterations. Although white blood cell count does not seem to be associated with severity of OCs and visual outcomes, it may furnish an idea on the patient’s immunological status, as immunodeficiency may be linked to worst sequelae [38,42,72]. Once diagnosis is confirmed,

empirical therapy must be administered with oral (stage I) or intravenous (stage II-V) broad spectrum antibiotics with a good blood-brain-barrier penetration, as well as steroids, analgesics and nasal saline irrigation. Moreover, some authors suggest high dose heparin for CST, even if its utility is still controversial [73-75]. Blood culture and nasal swabs may be useful in order to pinpoint the pathogen and tailor the antibiotic therapy [35]. Urgent TNES is recommended if the patient fulfills at least one of the following criteria:

- intraocular pressure > 20 mmHg;
- ophthalmoplegia;
- proptosis > 6 mm;
- acute optic nerve or retinal compromise with an impairment of BCVA;
- recurrence of OC after a previous surgical drainage;
- evidence of chronic sinusitis (e.g. nasal polyposis);
- suspicion of anaerobic infection (i.e. infection of dental origin);
- preseptal and postseptal cellulitis that do not show any significant clinical improvement after 24-48 hours of antibiotic therapy;
- SPOA with a non-medial location and/or with a width > 4 mm;
- orbital abscesses and CST [76,77].

Patients with OCs have a statistically significant reduced risk of blindness if TNES is performed within 48 hours from ocular symptoms onset, regardless of initial Chandler's stage [38]. Similarly, an early diagnosis and an early treatment are significant prognostic factors for a favorable neurological outcome when facing a CST [35]. If an IC or a sinus fungal infection could not be excluded, a CT scan with contrast or an MRI should be further obtained [73,78]. Immediate surgery, consisting of both TNES and open neurosurgical approach, is essential for the treatment of an IC (apart from meningitis that usually heals with antibiotics alone) to prevent neurological sequelae (e.g. focal neurological deficits, change personality) and death, whose incidence rates amount to 33% and 2-7%, respectively [36,40,79-81].

AIFR typically affects immunocompromised patients, and its aggressiveness is due to the ability of the hyphae to invade both mucous membranes and neurovascular structures [44,82]. Elderly, immunosuppressant drugs and diabetes mellitus are all risk factors for immunological impairment and, thus, for fungal infection [43,45]. Both patients treated at our hospital presented at least two different risk factors for poor prognosis, and this surely played a role in the aggressiveness of their disease. Diagnosis is based on clinical history, symptoms (fever, swelling, nasal congestion, headache, proptosis, ophthalmoplegia, etc.) and MRI findings [81,82]. Patients with intracranial involvements and/or without surgical treatment appear to have higher risk of poor outcomes [53,83,84]. A prompt multidisciplinary management is of paramount importance, as estimated disease-specific mortality rate ranges from 14.0 to 61.8% [44,46]. Survivors may require orbital exenteration (2.0 - 21.0%) and suffer from devastating sequelae, such as visual loss and cranial nerves palsy [50,52]. Treatment must include the stabilization of the underlying immunosuppressant condition, systemic antifungal therapy and urgent TNES [44,50,53]. External approach should be carried out by neurosurgeons and/or ophthalmologists only when the necrotic tissue is unreachable through the nostrils.

PTON is an acute optic nerve injury with an estimated incidence of 4% of all severe blunted cranial and maxillofacial trauma [83]. Clinical findings usually include visual loss and a relative afferent pupillary defect. The correct management of PTON is still controversial [85,86]. Wait & See strategy may be beneficial, as well as mega- or high-dose intravenous steroids only. However, the association of high-dose intravenous corticosteroids and TNES for optic canal or optic nerve decompression seem to be the most effective therapeutic option, even if it is unclear the specific weight of each therapeutic element [64,87]. Theoretically, anti-edemigenous action of steroids and decompressive surgery reduce pressure on nervous fibers, and it is reasonable to believe that earlier the decompression, greater the number of rescue nervous fibers. In support of this hypothesis, data from literature shows how surgical decompression beyond 48-72 hours entails a lower BCVA improvement [56,57]. Albeit early steroidal and surgical intervention, our patients did not recover sight from the traumatized eye. Both came to our attention complaining of complete blindness and this may explain their poor outcome. Similarly, previous studies demonstrated as post-traumatic pre-operative BCVA represents an independent factor that may predict a satisfying visual outcome [62,87,88]. CSF was the most recurring surgical complication reported by authors, affecting 31 out of 540 patients (5.7%).

In the present paper, we showed that, in a major ENT referral department, almost one out of four ENT emergencies required TNES. The correct management of ENT emergencies begins preoperatively: clinical history, blood exams, physical and radiological examinations must be collected to distinguish non-elective from elective issues. Results from both literature and our experience highlighted the importance for a third level hospital to have a well-trained multidisciplinary team. Apart from an otorhinolaryngology with a proper expertise in TNES, a major ED should have various professional figures, such as ophthalmologists,

neurosurgeons, infectivologists, and radiologists, that collaborate and share diagnostic and therapeutic paths for the treatment of acute sinonasal diseases that are barely rare but potentially sight- and/or life-threatening. This study has some limits. First of all, the small number of patients treated at our department is the major limit of this study. Secondarly, we only considered papers published in the last 5 years and this might have distorted results. Nowadays, TNES is widely performed, and this may explain why we found higher success rates and lower complications rates if compared to those of the less recent literature. However, we believe that such a short period would have offered a more truthful view of the current efficacy and safety of non-elective TNES. To the best of our knowledge, this is the first paper that analyzes safety and efficacy of TNES in facing the most common otorhinolaryngological disorders that require surgical management within 48 hours from diagnosis. More studies are needed in order to develop strategies that may improve beyond outcomes of non-elective TNES.

Conclusion

In conclusion, technical and technological advances in endoscopy made TNES a safe and incisive procedure even in the emergency/urgency scenario, with a high success rate and a low complications rate. Future studies are advocated to further improve success rates of non-elective TNES and to prevent blindness and other long-term disabling conditions, as well as AIFR-related mortality.

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