

Nasomaxillary Fracture: Retrospective Review of 11 Consecutive Patients and Literature Review

Jérôme Adnot ^{1, *}, Cyril Desbarats ¹, Luc-Marie Joly ², Olivier Trost ^{1, 3, 4}

¹ Department of Oral and Maxillofacial Surgery, Rouen University Hospital, 1 rue de Germont, 76000 Rouen, France

² Emergency Unit, Rouen University Hospital, 1 rue de Germont, 76000 Rouen, France

³ Laboratory of anatomy, Rouen Faculty of Medicine, 22 boulevard Léon-Gambetta, 76000 Rouen, France

⁴ French National Institute for Health (INSERM), LIMICS UMR-1142, 76000 Rouen, France

*** Corresponding author:**

Dr Jérôme ADNOT, M.D.

Department of Oral and Maxillofacial Surgery (Rouen University Hospital)

1, rue de Germont, F-76000 Rouen, France

Tel: +33 232 888 146

E-mail: jadnot@live.fr

Funding

None

Declarations of interest

None

Abstract

Purpose: Nasomaxillary fractures can be mistaken for fractures confined to the nasal bones, resulting in inappropriate treatments that jeopardize patient outcomes. Our purpose here was to provide information on nasomaxillary fractures via a retrospective study and literature review.

Material and methods: We retrospectively collected clinical, computed tomography (CT), therapeutic, and outcome data in consecutive patients managed for unilateral impacted nasomaxillary fractures at our centre over a 5-year period (2013-2017). Long-term outcomes were further assessed by administering scoring tools for subjectively assessed cosmesis, nasal obstruction, and pain during a telephone interview.

Results: The 11 included patients had a mean age of 33.4 years. The clinical manifestations included nasal asymmetry in all 11 patients and infra-orbital rim step-off deformity in 9 patients. Consistent CT findings were involvement of the nasal bone, canine pillar, and anterior maxillary bone; and presence of blood within the maxillary sinus. The treatment in 8 patients consisted in open reduction and internal fixation via the intraoral approach, with or without an added infra-orbital approach; 1 patient was managed by endonasal reduction and 2 patients declined reduction. Almost 1 year after surgery, the cosmetic outcome was good (mean score, 22/25) and few patients reported nasal obstruction (mean score, 3.6/20) or pain (mean score, 1.6/10).

Conclusion: Nasomaxillary fracture is a specific entity that must be differentiated from nasal bone fracture. Open reduction and internal fixation via the intraoral approach, with an added infra-orbital approach if needed, provides good outcomes.

Keywords: Nasomaxillary fracture. Medial maxillary fracture. Nasal bone fracture. Nasoethmoid orbital fracture. Imaging studies. Treatment.

1. INTRODUCTION

Nasal fractures are common and may be confined to the nasal bones or involve various components of the nasoorbitoethmoid (NOE) complex. The diagnosis of nasal bone fracture rests on the physical examination, and no specific radiological investigations are usually recommended [1]. Endonasal reduction is the main treatment but often results in residual cosmetic and/or functional impairments. In contrast, NOE fractures result from higher energy trauma with a higher point of impact (on the nasion), require evaluation by computed tomography (CT) to ensure correct classification and to look for intracranial injuries, and must usually be treated by open reduction and internal fixation (ORIF). Between these two extreme forms of midface fracture are nasomaxillary fractures, which are often mistaken for nasal bone fractures as the clinical presentations are closely similar and imaging studies are not obtained routinely. In addition, physician awareness of nasomaxillary fractures is low, as these lesions are uncommon and have rarely been the focus of published studies [2]. The diagnosis is important, however, because applying the treatment strategy for nasal bone fractures to impacted nasomaxillary fractures results in poor cosmetic and functional outcomes.

The aim of this retrospective study was to report our experience with 11 patients managed at our department for impacted nasomaxillary fractures. Based on our data, we suggest new strategies for managing nasal trauma.

2. MATERIAL AND METHODS

2.1. Study design and patients

We retrospectively reviewed consecutive cases of impacted nasomaxillary fracture treated at our oral and maxillofacial surgery department between January 2013 and January 2017. The inclusion criterion was a unilateral nasomaxillary fracture that was either isolated or combined with an ipsilateral fracture of the orbito-zygomatic complex. Bilateral nasomaxillary fractures (i.e., some types of NOE fractures) were excluded. All patients presented initially at the emergency department and were evaluated further a few days later as outpatients at the oral and maxillofacial surgery department.

2.2. Nasomaxillary fracture definition

The nasomaxillary fracture diagnosis was considered if the fracture involved the nasal bones, the maxillary frontal process, anterior part of the maxilla, and canine pillar without medial canthal tendon avulsion (Figure 1).

2.3. Data collection

The following information was abstracted from the patient files at the time of the outpatient clinic assessment: age, sex, side of fracture, aetiology, nasal pain, nasal deformity, epistaxis, infra-orbital rim step-off deformity, ecchymosis, infra-orbital hypoesthesia, diplopia, canthal dystopia, epiphora, oedema, and nasal obstruction. CT scans were available for all patients. For the study, the following data were collected based on a review of the CT images using Carestream[®] software (Carestream Health, Onex, Toronto, Canada): exact location of the fracture lines, with the bones involved; medial displacement of the impaction; and horizontal distance between the lowest part of the nasomaxillary buttress and the piriform aperture measured on coronal sections through the nasopalatine canal. Finally, the surgical reports were reviewed for information on the surgical procedures including time to

surgery, operative time, approach (external and/or intraoral, with the type of approach), internal fixation device, and intranasal and/or extranasal splinting).

In addition to the above-listed retrospective data, information on long-term outcomes was collected during a telephone interview with each patient. A standardised questionnaire was used to assess the cosmetic outcome as perceived by the patient (Subjective Evaluation of Appearance score, designed for this study; Table 1), nasal obstruction (Nasal Obstruction Symptom Evaluation, NOSE; Table 2), and residual pain (visual analogue scale, VAS).

3. RESULTS

3.1. Patients

We identified 11 patients, 8 males and 3 females with a mean age of 33.6 years (range, 15-70 years) (Table 3). The left side was involved in 7 patients and the right side in 4 patients. The cause of the fracture was a fight in 5 patients, motor vehicle accident in 2 patients, fall in 2 patients, sports injury in 1 patient, and domestic injury in 1 patient. Short-lived epistaxis immediately after the trauma was a consistent feature.

3.2. Clinical manifestations

At the time of the outpatient visit to our department about 5 days on average after the trauma, all 11 patients had a nasal deformity and 10 also had persistent oedema of the nasal region. A palpable step-off deformity of the infra-orbital rim indicating extensive impaction of the medial nasomaxillary buttress into the infra-orbital rim was noted in 9 patients. Pain in the nasal region was reported by 8 patients. A bilateral ecchymosis was visible in 7 patients. A less common manifestation was nasal obstruction, reported by 4 patients and consistently confirmed by the mirror test. Finally, infra-orbital hypoesthesia suggesting damage to the

maxillary nerve at the orbital floor was noted in 3 patients. None of the patients had diplopia, epiphora, or canthal dystopia.

3.3. Computed tomography (CT) findings

The CT images consistently showed fracture lines involving the nasal bones, canine pillar, and anterior wall of the maxillary sinus, which contained blood (Figures 2 and 3). In 10 patients, the diagnosis was isolated impacted nasomaxillary fracture. The remaining patient had an ipsilateral orbito-zygomatic fracture. The other bony structures involved were the orbital floor (n=9), frontal process of the maxilla (n=9), medial wall of the orbit (ethmoidal labyrinth, lacrimal bone; n=9), and nasolacrimal canal (n=7). In addition, nasal septum dislocation was noted in 1 patient.

The fracture was classified as complex in 4 patients based on the presence of intermediate fragments and/or comminution. Mean medial displacement was 5 mm (range, 2-10 mm).

3.4. Treatments

Reduction was offered to all patients but was declined by 2. Table 3 provides details on the treatments used. Of the 9 patients who had surgery, 1 was managed by endonasal reduction, endonasal mesh insertion, and extranasal splinting and 8 were managed by ORIF via a superior vestibular approach only (n=3), a combined vestibular and external mid-palpebral approach (n=4) (Figures 4 and 5), or a trans-lesional approach (n=1). Internal fixation was on the infra-orbital rim in 5 patients (Leibinger Universal Upperface[®] screw-plate, Stryker, Kalamazoo, MI) and on the canine pillar in 7 patients (Leibinger Universal Midface[®] screw-plate, Stryker) (Figures 6 and 7). Orbital floor reconstruction was necessary in 3 patients, in whom the shape of the orbital floor injury allowed the use of thin silicone

membranes (Folioxane[®], Novatech SA, La Ciotat, France). Nasal meshes were inserted in 5 patients. All patients wore a nasal thermoformed splint night and day for 10 days then only at night for the following week. A 1-week course of antibiotics was prescribed routinely.

3.5. Long-term outcomes

Complications noted during follow-up included an unsightly infra-orbital scar left by a facial wound, which had been used to approach the fracture (n=1); persistent maxillary nerve paraesthesia (n=1), persistent nasal deformity (n=1), and chronic nasal obstruction (n=3 including 1 of the 2 patients who had declined reduction).

Of the 11 patients, 8 completed the questionnaires during the telephone interview. Table 4 reports the findings.

4. DISCUSSION

Many physicians have little knowledge about nasomaxillary fractures, which are therefore often mistaken for fractures confined to the nasal bones. Nasomaxillary fractures involve not only the nasal bones but also the maxillary frontal process, infra-orbital rim, anterior part of the maxilla, and canine pillar [4]. In addition, the orbital floor and/or medial orbital wall may be fractured (10 and 9 of our 11 patients, respectively).

Nasomaxillary fractures were first specifically described in 1971 as the second leading cause of infra-orbital rim step-off deformity among orbito-zygomatic fractures [5]. In contrast, a 1988 report used the term 'medial infra-orbital rim fracture' and emphasized the differences with orbito-zygomatic fractures [6]. The term 'medial maxillary fracture' was introduced in 1991 [7]. In the widely used Markowitz and Manson classification of NOE fractures, nasomaxillary fractures are classified as type 1 unilateral naso-ethmoid orbital

fractures [8]. However, a 2012 study distinguished nasomaxillary fractures from NOE fractures based on the presence of medial canthal tendon avulsion with canthal dystopia only in the latter [9]. A new surgical technique for managing nasomaxillary fractures was described in 2016 [2]. **In the AOCMF classification system for midface fracture, a left nasomaxillary fracture is coded: 92 U.I.L [10, 11] but it must be specified there is no medial canthal tendon avulsion. This AOCMF classification is based on the Markowitz and Manson classification for fractures involving the NOE bones [12].**

Nasomaxillary fractures are believed to be uncommon, and few data about them are available. However, as these fractures can be readily mistaken for nasal bone fractures, their true incidence and prevalence may be underestimated. In turn, the dearth of published information contributes to the low level of awareness of nasomaxillary fractures among physicians.

The position of the nasal bones as the most anteriorly prominent bones of the face, together with their thinness, explains the high frequency of nasal bone fractures. In a study of maxillofacial fractures in 2011, 66.4% of the 637 patients had nasal bone fractures [13]. Nasomaxillary fractures result from an impact at a lower and more lateral site, at the junction of the nasal bone, infra-orbital rim, and nasomaxillary buttress. At this site, the thicker bone requires a higher energy trauma to fracture compared to the nasal bones.

Most of the clinical manifestations of nasomaxillary fractures are shared with nasal bone fractures, including oedema, ecchymosis, nasal deformity, nasal obstruction, pain, and epistaxis. Two signs must be sought routinely, as they suggest that the nasal bones are not the only ones involved, i.e., a step-off deformity at the medial infra-orbital rim and infra-orbital paraesthesia. Failure to identify these signs can lead to the nasomaxillary fracture being mistaken for a nasal bone fracture, with the result that no imaging studies are obtained and that an inappropriate treatment is provided. The functional and cosmetic outcomes are

governed by the appropriateness of the treatment. Experience shows that reduction is often difficult and unstable even with an open approach, thus closed reduction carries a risk of poor reduction and functional impairments such as nasal obstruction, which is difficult to treat. The oedema often masks the asymmetry caused by the fracture, and severe pain may limit the ability to detect a step-off deformity by palpation of the infra-orbital rim. Consequently, re-examining the patient after a few days is often useful.

CT with 3D reconstruction of bone-window images is the reference standard for diagnosing facial bone fractures. The exact location of the fracture lines can be determined and the amount of impaction assessed accurately. The maxillary sinus was seen to contain blood in all our patients, whereas this finding is uncommon in patients with nasal bone fractures. The fracture line often extends to the infra-orbital canal, orbital floor, and/or medial orbit. As indicated above, low awareness of nasomaxillary fractures may result in these being misdiagnosed as nasal bone fractures, for which no imaging studies are recommended. A Gosserez radiograph or lateral radiograph of the nasal bones documents nasal bone fractures and constitutes useful evidence in the event of litigation. Although widely performed in everyday practice, these radiographic views are not among recommended investigations and fail to provide therapeutic guidance. In contrast, the Waters view can show not only the nasal bone fracture with an interruption in the contour of the piriform aperture, but also two other findings, namely, an air-fluid level in the sinus indicating the presence of blood, which is a consistent feature in patients with nasomaxillary fractures; and loss of continuity of the McGrigor-Campbell B line, which is not detectable on the other views. These findings alert to the possibility of a nasomaxillary fracture and, therefore, to the need for a CT scan. The role for cone beam CT in the diagnosis of facial injuries remains unclear, as the availability of this investigation is limited. However, when available, cone beam CT may prove helpful to rapidly provide the accurate diagnosis with a

lower radiation dose compared to CT in patients with isolated nasal trauma but findings suggesting nasomaxillary fracture on the Waters radiograph.

ORIF is reported to be the optimal treatment for nasomaxillary fractures. A double external and intraoral approach is used in most cases. We advocate routine use of the intra-oral vestibular approach to reduce the canine pillar after subperiosteal dissection and nasal mucosa elevation with a thin Obwegeser elevator. If this method fails to achieve reduction or if the orbital floor requires revision, we recommend an infra-orbital approach to expose the medial part of the infra-orbital rim. A Gillis hook can then be used to pull the fragment into place. For the infra-orbital approach, the incision can be external (sub-ciliary, mid-palpebral, or infra-palpebral) or trans-conjunctival. Alignment of both the infra-orbital rim and the piriform aperture contour must be achieved. Nasal meshes are inserted for 5 days. An external nasal splint is recommended to maintain the position of the nasal bones, which are not involved by the internal fixation. Surgery is best performed 5 to 10 days after the injury, as the development of fibrous tissue may hinder reduction after this interval. **Closed technique for NOE fractures using intravenous cannula has been described for repositioning of the bone fragment and the medial canthal tendon [14], this technique is interesting because of the absence of long-term implant and minimal scar, however we believe that reduction cannot be as well performed as with an open approach.**

Non-operative treatment by endonasal reduction and nasal meshes has been reported [2, 6] but may carry a high risk of residual cosmetic and functional impairments. More specifically, insufficient reduction by the endonasal manoeuvres may be followed by nasal obstruction. We do not recommend this treatment. In previous studies, most patients with nasomaxillary fractures were managed surgically. Table 5 lists the treatment used in five publications retrieved from PubMed using the indexing terms 'nasomaxillary fracture' OR 'medial maxillary fracture' [2, 5-7, 9].

In conclusion, nasomaxillary fractures are of intermediate severity between nasal bone fractures and NOE fractures. In patients with simple nasal trauma and no suspicion of NOE fracture, a meticulous physical examination is required to look for a step-off deformity of the infra-orbital rim and/or infra-orbital hypoesthesia. If either or both of these two signs is present, we recommend obtaining a Waters radiograph to assess the infra-orbital rim (McGrigor-Campbell lines) and the maxillary sinus (hematosinus). If abnormalities are found, CT must be performed. The role for cone beam CT in facial injuries needs to be clarified. We believe that nasomaxillary fractures should be managed by ORIF, using the intra-oral vestibular approach, combined if needed with an infra-orbital approach.

References

- [1] Peterson BE, Doerr TD. Utility of computed tomography scans in predicting need for surgery in nasal injuries. *Craniofacial Trauma Reconstr* 2013;6:221-4.
- [2] Hwang K, Kim HM. A reduction technique for a depressed and impacted nasomaxillary buttress fracture. *J Craniofac Surg* 2016;27:537-9.
- [3] Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. *Otolaryngol Head Neck Surg* 2004;130:157-63.
- [4] Trost O, Peron JM. Regarding unilateral nasomaxillary buttress fractures. *J Plast Reconstr Aesthetic Surg* 2014;67:278-9.
- [5] Morgenstein KM, Bloom BS. Naso-maxillary fracture. *Eye Ear Nose Throat Mon* 1971;50:331-3.
- [6] Anderson AG, Frank TW, Loftus JM. Fractures of the medial infraorbital rim. *Arch Otolaryngol Head Neck Surg* 1988;114:1461-3.
- [7] Hillstrom RP, Moore GK, Mathog RH. Medial maxillary fractures. *Otolaryngol Head Neck Surg* 1991;104:270-5.
- [8] Markowitz BL, Manson PN, Sargent L, Vander Kolk CA, Yaremchuck M, Glassman D, Crawley WA. Management of the medial canthal tendon in nasoethmoid orbital fractures: the importance of the central fragment in classification and treatment. *Plast Reconstr Surg* 1991;87:843-53.
- [9] Frodel JL. Avoiding and correcting complications in perinasal trauma. *Facial Plast Surg* 2012;28:323-32.

- [10] Kunz C, Audigé L, Cornelius CP, Buitrago-Téllez CH, Frodel J, Rudderma n R, Prein J. The Comprehensive AOCMF Classification System: Midface Fractures – Level 2 Tutorial. *Cranio maxillofac Trauma Reconstr* 2014;7(Suppl 1):S059-67.
- [11] Cornelius CP, Audigé L, Kunz C, Buitrago-Téllez CH, Rudderma n R, Prein J. The Comprehensive AOCMF Classification System: Midface Fractures – Level 3 Tutorial. *Cranio maxillofac Trauma Reconstr* 2014;7(Suppl 1):S092-102.
- [12] Audigé L, Cornelius CP, Di Leva A, Prein J, CMF Classification Group 6. The First AO Classification System for Fractures of the Craniomaxillofacial Skeleton: Rationale, Methodological Background, Developmental Process and Objectives. *Cranio maxillofac Trauma Reconstr* 2014;7(Suppl 1):S006-14.
- [13] Latifi H. Prevalence of different kinds of maxillofacial fractures and their associated factors are surveyed in patients. *Glob J Health Sci* 2014;6:66-73.
- [14] Jose, Nagori SA, Agarwal B, Roychoudhury A. Closed technique for naso-orbito-ethmoid fracture management: Technical note. *J Stomatol Oral Maxillofac* 2018;119:242-4.

FIGURE LEGENDS

Figure 1

Nasomaxillary fracture scheme, right profile view

Figure 2

Facial CT, bone window, coronal view: impacted nasomaxillary fracture on the right, with right nasal stenosis due to medial displacement of the canine pillar

Figure 3

Facial CT with volume-rendering reconstruction, right lateral view: impacted nasomaxillary fracture on the right with a clearly visible step-off deformity of the infra-orbital rim

Figure 4

Intra-operative view: infra-orbital approach showing the nasomaxillary fracture and a third fragment after reduction

Figure 5

Intra-operative view: intra-oral approach showing the nasomaxillary fracture and interruption of the canine pillar

Figure 6

Internal fixation of the canine pillar fracture restores the previous nasal shape and patency

Figure 7

Internal fixation of the infra-orbital rim

Table 1. Subjective evaluation of the cosmetic outcome: Subjective Evaluation of Appearance (SEA) score, with a range of 5 (worst possible outcome) to 25 (best possible outcome)

Please answer each of the following questions on a scale from 1 to 5 where

- 1 indicates complete disagreement
- 2 indicates disagreement
- 3 indicates neither agreement nor disagreement
- 4 indicates agreement
- 5 indicates complete agreement

Questions:

- I am satisfied with the result of the surgery (1-2-3-4-5)
- I am satisfied with the symmetry of my face (1-2-3-4-5)
- I am satisfied with the appearance of my nose (1-2-3-4-5)
- I am satisfied with the appearance of the scars caused by the surgery (1-2-3-4-5)
- I feel the same as before the injury (1-2-3-4-5)

The SEA score can range from 5 (worst possible outcome) to 25 (best possible outcome).

Table 2 NOSE scale (Nasal Obstruction Symptom Evaluation). Each patient was asked to score each of the five symptoms from 0 (absent) to 4 (severe)

Over the past month, how much of a problem were the following conditions for you?
Please choose the most correct response.

	Not a problem	Very mild problem	Moderate problem	Fairly bad problem	Severe problem
1. Nasal congestion or stuffiness	0	1	2	3	4
2. Nasal blockage or obstruction	0	1	2	3	4
3. Trouble breathing through my nose	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

Table 3. Main features in the 11 patients

Patients	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total or Mean
Surgery	yes	yes	yes	yes	yes	yes	yes	yes	yes	Refused	Refused	9
Displacement (mm)	10	5	2	2	7	4	8	5	6	6	3	Mean = 5
Time to surgery, days	6	12	11	27	11	10	6	12	13	NA	NA	Mean = 11
Hospital stay length, days	2	2	2	2	2	2	2	2	2	NA	NA	Mean = 2
Operative time, minutes	70	40	45	60	45	30	130	60	15	NA	NA	Mean = 55
Infra-orbital approach	yes	no	no	yes ^a	yes	no	yes	yes	no	NA	NA	5
Intra-oral approach	yes	yes	yes	no	yes	yes	yes	yes	no	NA	NA	7
Orbital floor reconstruction	no	no	no	yes	yes	no	yes	no	no	NA	NA	3
Nasal splinting	yes	yes	yes	no	no	yes	no	no	yes	NA	NA	5

^aThe surgical approach was through the lesion.

NA, not applicable

Table 4. Outcomes as assessed by the telephone interview in 8 of the 11 patients

Patient #	SEA score	NOSE score	VAS pain score
#2	24	1	0
#4	18	7	7
#5	25	1	0
#6	25	0	0
#7	21	0	0
#8	20	12	4
#9	21	4	0
#11 (no surgery)	xxx	19	3
Mean for the 7 operated patients	22	3.6	1.6

SEA, Subjective Evaluation of Appearance, scored from 5 (best possible appearance) to 25 (worst possible appearance); NOSE, Nasal Obstruction Symptom Evaluation, scored from 0 (no symptoms) to 20 (severe symptoms); VAS, visual analogue scale, scored from 0 to 10

Table 5. Previously published data

First author, N of patients	Anderson 7	Hilstrom 6	John 2	Yoshioka 8	Hwang 15	Total 38
Step-off deformity	7	6	2	NS	NS	15/15
ORIF	6	6	2	6	14	34/38
Intraoral approach	NS	6	2	8	10	26/31
Infraorbital approach	6	5	2	6	5	24/38
Orbital floor reconstruction	NS	5	NS	4	NS	9/14

NS, not specified













