

## SUPPLEMENTARY DIGITAL MATERIAL 1

### **A general clinical approach to the diagnosis of nasal obstruction in athletes**

In athletes that present with nasal symptoms, we propose that SEM physicians consider the following stepwise approach to the diagnosis of nasal obstruction that is based on the classification of nasal obstruction.

#### *Step 1: Screen for possible nasal obstruction*

We propose that SEM physicians use the NOSE questionnaire to screen for the presence of nasal obstruction<sup>1</sup>. The NOSE questionnaire has been validated in several clinical populations, most recently in patients undergoing rhinoplasty<sup>2</sup>. The NOSE scale was found to be sufficient in structural validity, internal consistency, reliability, construct validity, and responsiveness, along with favourable interpretability and feasibility aspects. It was selected as the most suitable instrument to measure functional outcome. Even if the NOSE scale originally was designed to compare symptom severity before and after interventions or compare effects of different treatment in groups, it has proven to be a valuable tool in individual assessment<sup>3</sup>.

The NOSE questionnaire can be self-completed by athletes and consists of five symptoms suggestive of nasal obstruction where the athlete can rate each symptom by presence and severity the last month (score from 0-4; ranging between “not a problem” and “severe problem”) (Figure S1):

1. Nasal congestion or stuffiness
2. Nasal blockage or obstruction
3. Trouble breathing through my nose
4. Trouble sleeping
5. Unable to get enough air through my nose during exercise or exertion



## Nasal Obstruction and Septoplasty Effectiveness Scale



Physician AAO-HNS#: \_\_\_\_\_ Patient ID: \_\_\_\_\_ Today's date: \_\_\_/\_\_\_/\_\_\_

→ **To the Patient:** Please help us to better understand the impact of nasal obstruction on your quality of life by **completing following survey**. Thank You!

Over the past **ONE month**, how much of a **problem** were the following conditions for you?

Please **circle** the most correct response

	<i>Not a Problem</i>	<i>Very Mild Problem</i>	<i>Moderate problem</i>	<i>Fairly Bad Problem</i>	<i>Severe problem</i>
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

**Figure S1: The Nasal Obstruction and Septoplasty Effectiveness (NOSE) scale**

The sum of all 5 scores (range 0-20) is then multiplied with 5 to get a rating from 0-100. A sum-score of 30 appears to differentiate between patients with and without nasal obstruction<sup>3</sup>. However, some patients with nasal obstruction can have a score below 30, and despite having mild symptoms, their obstruction should not be ignored, but should be treated appropriate.

*Step 2: Obtain a detailed history of nasal symptoms, followed by a general medical history*

Other common nasal symptoms and the relative frequency / severity of these symptoms in conditions that can cause nasal obstruction are listed in Table S1, together with athletes at risk for each condition.

**Table S1: Nasal symptoms and athletes at risk for different causes of nasal obstruction**

Symptom/history	Structural	Mucosal*	
		Non-infectious	Infectious

	Static	Dynamic	CRS	Non-allergic/ Mixed	Allergic	
Symptoms of nasal obstruction (NOSE score)	+++	++	+++	+++	++	+++
Rhinorrhoea/Discharge	-	-	+++	+	+	+++
Post-nasal drip	-	-	+++	-	+++	+++
Sneezing	-	-	+	+	++	++
Nasal/palatal itch	-	-	-	+	+++	-
Facial pain/pressure/headache	-	-	+++	+	-	++
Loss of smell	-	-	+++	-	-	++
Sleep disturbance	+++	+	+++	++	++	+++
Unilateral obstruction	+++	+++	+	+	-	+
Exercise induced nasal obstruction	-	+++	?	+++	+	+
Trigger-induced nasal obstruction**	-	-	?	+++	+++	+++
<b>Athletes at risk</b>						
Contact sport	+++	+	-	-	-	+
Swimmers	-	-	+	+++	+++	++
Winter sport	-	-	?	+++	+	++
Endurance athletes	-	+	?	+++	+++	++

The number of + signs indicate the relative frequency / severity of symptoms for different causes of nasal obstruction and athletes at risk

NOSE: NOSE questionnaire

CRS: Chronic rhinosinusitis

\* Mucosal symptoms - adapted from Fokkens et al <sup>4</sup> and Hox et. al <sup>5</sup>.

\*\*Triggers can include cold, pollution, chlorine, chemical, allergens and others

A thorough history will almost be diagnostic for causes of nasal obstruction but needs to be confirmed with a comprehensive clinical examination and special investigations if needed.

In an athlete presenting with symptoms suggestive of nasal obstruction the following are key elements in the medical history:

1. What is the type of sport, level and hours of training per week?
2. When was the onset of symptoms?
3. Do the symptoms vary?
4. Are symptoms unilateral or bilateral?
5. Has there been a change in the sense of smell and taste?
6. Are there any exacerbating factors?
7. Are there any relieving factors?
8. Is their sleep effected and do they snore?

9. In what kind of situations does the athlete convert from nasal breathing to mouth breathing?

Additional elements to cover in the medical history include the following:

6. Has there been any previous trauma and / or nasal or facial surgery?
7. Does the athlete have any other medical problems?
8. What medication the athlete may be taking?
9. Is there a history of allergy or atopy in the family?
10. How is their quality of life (QOL), exercise training or sports performance affected by their presenting complaint?
11. Does the athlete smoke or use any recreational drugs?

*Step 3: Conduct a systemic examination of the nose to determine the causes of obstruction*

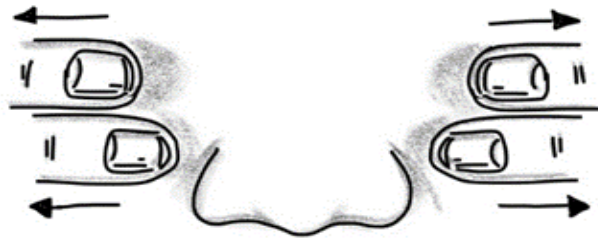
In addition to a general clinical examination, we propose that SEM physicians perform a systematic ear / nose / throat examination that minimally comprises of the following 4 elements;

1. **Ear:** Otoscopy to evaluate a normal tympanic membrane. Enlarged turbinates and chronic sinusitis with nasal polyps may obstruct the Eustachian tube leading to chronic mucoid otitis media as a presenting complaint.
2. **Throat:** Palpation of the neck and an oral examination to determine if there is a high riding palate, remnants of the tonsils or adenoids and mucosal inflammation. In addition, palpate the neck for swollen lymph nodes and tumours.
3. **Cranial nerves:** A brief screening of olfaction, facial sensation and tongue motility is essential. If any neurological fallout is suspected, then conduct a full evaluation of the 12 cranial nerves.
4. **Nose:** Examination of the nose (*observation*) should start at the time of meeting the athlete for the first time. The breathing pattern and evidence of mouth breathing should be noted. If there is a slight gap between the lips when the athlete is not talking, this is highly suggestive of nasal obstruction. Evidence of nasal deformation and signs of infection or allergy should be observed.

The next step is to *evaluate* the nose by comparing it to the rest of the face and inspecting the nose from the side, the front and from below. Look for symmetry, deformity, signs of trauma or any cartilaginous septal protrusion. Repeat the evaluation when the athlete

smiles, and inhales in forcefully through the nose with the mouth closed. *Palpate* the nose and feel how strong the nasal tip is, and assess for bony asymmetry and tenderness over the frontal or maxillary sinuses. The final step is to *inspect* the anterior nasal passages (anterior rhinoscopy). A headlamp is superior to a torch as it gives the examiner two free hands. The athlete is asked to tilt the head slightly backwards and an appropriately sized nasal speculum is gently inserted while it is closed. When the speculum is opened vertically, it needs to rest on the nasal sill and the anterior soft triangle. It must not be opened horizontally so that it does not push against the septum and the lateral nasal wall because this is very uncomfortable for the athlete. The following features can be identified on each side: observing for differences between sides, how straight the septum is, how large the inferior turbinate is, how far the examiner can see into the nose, the state of the nasal mucosa, any secretions, any septal spurs or a septal perforation. If an internal nasal valve collapse is suspected, an earbud to gently lateralise the upper cartilage and if an external valve collapse is suspected, then the lower lateral cartilage can be lateralized. A change in the sensation of breathing before and after performing these manoeuvres indicates that nasal valve collapse is a possible cause of obstruction.

Additional in-office screening tests can be performed. A test to distinguish between the patency of each nostril can be carried out by taping the opening of one nostril at a time. This will give a subjective indication that airflow obstruction through one nostril. The physician should also listen for the difference in the sound of nasal breathing and observe if there is valve collapse. This is done at rest, repeated with forced nasal breathing, and is a valuable clinical office test to elicit if there is a dynamic obstruction. If there is no evidence of a nasal discharge, nasal patency can be also be tested before and after decongestion with oxymetazoline and this can distinguish between structural and mucosal obstructions <sup>6</sup>. If an internal nasal valve collapse or external nasal valve collapse is suspected, upper and lower lateral cartilages respectively should be examined. This can be done by determining of nasal if airflow (asking the athlete to breathe through the nose) is improved before and after: i) performing the Cottle's manoeuvre, which is a test in which the cheek on the side to be evaluated is gently pulled laterally with one to two fingers to open the valve (Figure S2), or ii) placing a nasal dilator strip over the upper or lower lateral cartilages, or iii) using instrumentation to lateralise the upper lateral cartilages and asking the patient for any subjective improvement in symptoms <sup>7 8</sup>.



*Illustrated by Hege Clemm*

## **Figure S2: The Cottle test**

*Step 4: Decide on the use of special investigations to determine the nature, severity and cause of nasal obstruction*

The SEM physician can consider some special investigations to confirm the diagnosis of nasal obstruction. Special investigation to confirm the diagnosis of structural pathologies tests include nasal airflow tests (such as Four Phase rhinomanometry, acoustic rhinometry, Peak Inspiratory Nasal Flow), nasal endoscopy and a computerised tomography (CT) Scan of the nose and paranasal sinuses. The diagnosis of mucosal pathologies can be confirmed by considering a nasopharyngeal swab (PCR and culture for infections – only if indicated), blood tests (full blood count, eosinophil count, CRP), allergy screening (Serum IgE, skin prick tests), and a CT Scan of the nose and paranasal sinuses. These special investigations can either directly assist the SEM physician in the diagnosis and management of a nasal obstruction, or will be performed when the athlete refers the athlete to an otorhinolaryngologist.

## **References:**

1. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*. 2004;130(2):157-163.
2. van Zijl F, Mokkink LB, Haagsma JA, Datema FR. Evaluation of Measurement Properties of Patient-Reported Outcome Measures After Rhinoplasty: A Systematic Review. *JAMA Facial Plast Surg*. 2019;21(2):152-162.
3. Lipan MJ, Most SP. Development of a severity classification system for subjective nasal obstruction. *JAMA Facial Plast Surg*. 2013;15(5):358-361.
4. Fokkens WJ, Lund VJ, Hopkins C, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. *Rhinology journal*. 2020;0(0):1-464.
5. Hox V, Beyaert S, Bullens D, et al. Tackling nasal symptoms in athletes: Moving towards personalized medicine. *Allergy*. 2021.

6. Bende M, Loth S. Vascular effects of topical oxymetazoline on human nasal mucosa. *The Journal of laryngology and otology*. 1986;100(3):285-288.
7. Clement PA. Committee report on standardization of rhinomanometry. *Rhinology*. 1984;22(3):151-155.
8. Gruber RP, Lin AY, Richards T. Nasal strips for evaluating and classifying valvular nasal obstruction. *Aesthetic Plast Surg*. 2011;35(2):211-215.