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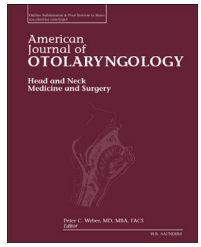

An experimental study of pain upon stimulation of the nasal and sinus cavities☆

*Dean M. Clerico, MD**

190 Welles St., Forty Fort, PA

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ABSTRACT

Objective: To map different areas of pain sensitivity and to determine the existence and/or pattern of referred pain from upon stimulating the sinonasal cavity.
Study design: Experimental human study.
Methods: Mechanical and electrical stimulations to various anatomical structures and areas of the nasal and sinus cavities were conducted on nine volunteers. Intensity, location and character of pain were recorded in all subjects.
Results: The postero-superior (cephalic) aspect of the nasal cavity, primarily the anterior face of the sphenoid sinus and the superior turbinate, were the most sensitive sites, and the antero-inferior (caudal) region was the least sensitive. Referred pain to the head and face was reported by several subjects.
Conclusion: Topographical differences in pain sensitivity exist in the sinonasal cavity. The phenomenon of referred pain from the nasal cavity was demonstrated.

1. Introduction

In 1943, McAuliffe, Goodell and Wolff published their landmark study on pain referred from the sinonasal cavity [1]. This famous "Wolff study", named after the senior author Harold Wolff, is often quoted in the medical literature by both neurologists and otolaryngologists in describing headache referred from the nose and sinuses, including mucosal contact headaches (MCH). MCH is a controversial clinical entity which proposes that physical contact between structures within the sinonasal cavity, predominantly between the septum and turbinates, elicits referred headache pain. More recently, Abu-Bakra and Jones [2] were unable to duplicate Wolff's findings, calling into question the role of mucosal contact in the etiology of facial pain. Both groups subjected volunteers to a variety of intranasal stimuli, whereupon subjects reported pain characteristics and any other associated symptoms. Wolff's group found that the maxillary and frontal sinus ostia were the most pain-sensitive areas, followed by the turbinates. The mucosa lining the sinuses was relatively insensitive. They concluded that stimulating areas within the sinonasal cavity produced referred pain, and the pain resulting from sinus inflammatory disease was largely due to inflammation around the ostia and engorgement of the turbinates.

Abu-Bakra and Jones sought to investigate the validity of claims that mucosal contact causes headache. As a result, they did not stimulate sinus ostia or mucosa. In addition to applying mechanical pressure with a Jobson probe, they stimulated nasal mucosa with substance P (SP), a neuropeptide previously thought to be an important mediator in pain transmission within the trigeminal system [3]. They found the middle turbinate to be the most sensitive structure stimulated, but were unable to elicit referred pain from their volunteers. The authors conclude that "there is no evidence of a causal relationship between contact points and facial pain" [2].

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* *190 Welles St.*, Forty Fort, PA. Tel.: +1 570 283 0524; fax: +1 570 283 0302.
E-mail address: dmclerico@yahoo.com.

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We attempted to repeat the experiments of Wolff's group and Abu-Bakra and Jones, with some modifications. We used electrical and mechanical (balloon catheter) stimuli. Like Abu-Bakra and Jones, we used endoscopic visualization to more precisely place the stimulus. We did not use topical epinephrine, as both previous investigators did, due to dripping and the difficulties of limiting the stimulus to the area applied. Nor did we use SP as a stimulus because more recent research points to calcitonin gene-related peptide (CGRP), rather than SP, as a more important mediator of pain transmission in headache [4].

Our goal is to plot topographically differences in pain sensitivity within the sinonasal cavity, and to discover if referred pain from the nose actually occurs. These results may have relevance in validating MCH as a clinical entity.

2. Materials and methods

Nine healthy volunteers (seven men and two women) were recruited for this study. In order to directly visualize and stimulate sinus ostia and mucosa, we chose (three) who had undergone endoscopic sinus surgery (ESS) at least 1 year prior to the study and who were asymptomatic for at least 9 months. These post-ESS subjects were included because there is no more reliable way of evaluating sensitivity within a given sinus or at its ostium than by direct visualization (not always possible in subjects who have not undergone ESS). Exclusion criteria for all subjects included history of headaches, active upper respiratory illness, history of nasal trauma other than surgery, previous septoplasty, and current pain medication use. Ages ranged from 18 to 45 with a mean of 32.6 years. IRB approval was obtained from the Commonwealth Health System — Wilkes-Barre General Hospital IRB committee.

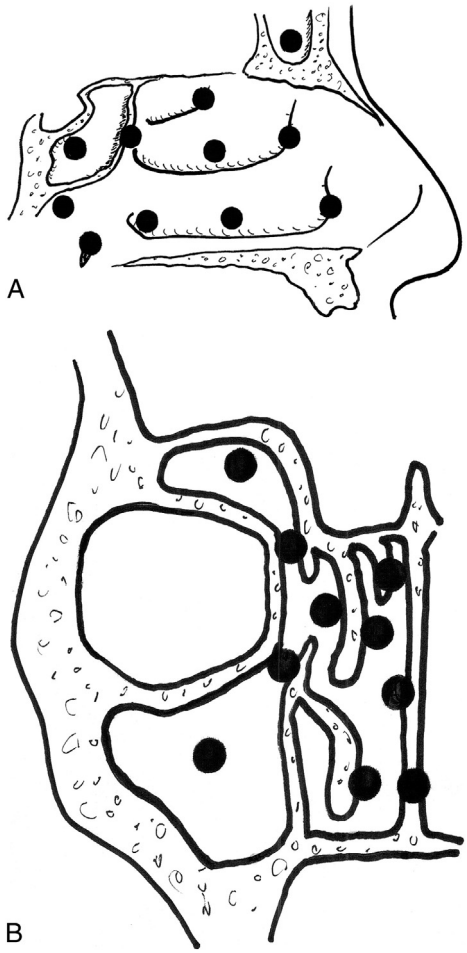

Fig. 1 – Schematic sagittal views of lateral nasal wall (A) and coronal view of sinuses (B) with dots indicating structures/areas stimulated.

Table 1 – Number of stimulations per method.

Structure/region stimulated	Electrical	Mechanical	Total number of stimulations
Face of sphenoid	4	1	5
Superior turbinate	8	9	17
Septum — posterior	8	0	8
Agger nasi	3	4	7
MT — medial surface	7	9	16
Maxillary os	5	4	9
Frontal sinus	2	2	4
Eustachian tube	4	3	7
Frontal recess/os	7	7	14
Septum — mid region	8	8	16
MT — lateral surface	6	6	12
IT — mid region	7	8	15
Sphenoid sinus	2	3	5
Maxillary sinus	2	2	4
IT — posterior	6	8	14
MT — anterior aspect	8	0	8
Nasopharynx	7	2	9
Septum — anterior	8	8	16
IT — anterior	8	8	16
Total	110	92	202

Footnote: MT = middle turbinate; IT = inferior turbinate.

Each subject was seated upright in an exam chair. Both nasal cavities were sprayed with 1% topical ephedrine solution for decongestion. A Karl Storz 30 degree nasal telescope was used for endoscopic visualization. Electrostimulation was administered with an Elmed ESU 70B monopolar on pure cut mode utilizing a nasal probe handpiece. The wattage at which each subject rated the pain as a "1" on a 1–10 scale when the probe was applied to the anterior tongue was used as each subject's threshold intensity. Intranasal stimulation was then carried out at this intensity for each subject. A Fogarty biliary balloon probe catheter 5 French 23 cm length with attached 3 cc syringe was used to generate mechanical pressure stimuli. An accompanying wire stylet was used to help maintain necessary rigidity to the catheter during stimulation. The application of stimuli was randomized with the volunteer blinded as method and anatomical area of stimulation. The duration of stimulus varied with the volunteer's tolerance, but did not exceed 30 seconds.

Data was collected on each subject at the time of stimulation. Intensity, location, and character of pain were recorded in all volunteers. Subjects were asked to locate on a