Rhinology, 32, 45-46, 1994

The Sheffield Nasal Pressure Probe: The development of a new device to measure intranasal pain thresholds*

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SUMMARY *We present the development of a mechanical pressure probe which was constructed from items readily available to most university departments. The device is simple to operate and gives repeatable determinations. Its main use has been to measure the pressure thresholds for pain in the nasal mucosa.*

Key words: nasal pressure, pain objectivation, intranasal pain, headache

INTRODUCTION

Sluder (1920) put forward the concept of mucosal contact pressure zones, particularly involving the middle turbinates and septum, as one cause of headache. Further experimental work by Wolff in the 1940s confirmed the somatotopic surface projections of pain resulting from pressure and electrical stimuli applied within the nasal fossa and sinuses (Stevenson, 1987). More recently, nasal endoscopists have re-affirmed the importance of nasal mucosal contact pressure zones as a cause of facial pain and headache (Stammberger and Wolf, 1988). We were interested in measuring the pressure required to produce pain at various specific anatomical sites in the nose. To achieve this we developed and built the Sheffield Nasal Pressure Probe.

MATERIAL AND METHODS

We needed to develop a probe that could be precisely placed within the narrow nasal cavities and apply increasing pressure to the nasal mucosa to allow us to accurately measure nasal pain thresholds.

At first we studied the use of a small angioplasty balloon catheter fixed to a mercury manometer. This proved unsuitable for several reasons; firstly, the balloon needed very high inflation pressures and it proved difficult to easily convert intraluminal pressures to the external pressures exerted on the nasal mucosa. Secondly, it was difficult to judge the exact contact area the balloon made with the nasal mucosa and as the balloon was inflated it impinged on several areas within the nasal cavity all of which could be responsible for producing the painful sensation. In view of these difficulties the balloon was abandoned and a spring-loaded applicator was designed and built (Figure 1), the overall dimensions being $19 \times 5.5 \times 1.2$ cm.

The probe handle is fashioned from perspex, one end of which is expanded with gradations marked linearly along an arch described by the stainless steel shaft, and thus acts as an accurate scale (Figure 1). The stainless steel shaft (12-gauge stainless steel hypodermic tubing; Coopers Needle Works, Birmingham, U.K.) pivots on a fulcrum incorporated into the opposite end of the handle to the scale, and protrudes for about 4 cm from the handle. This allows easy, accurate access to the nasal cavities. The movement of the stainless steel shaft is resisted by a spring also incorporated into the handle. Interchangeable plastic probe tips formed from Delrin (extruded acetal polyoxymethylene rod; Amari Plastics plc., Leeds, U.K.) are mounted onto the stainless steel shaft with the probe tip head being at 90° to the shaft. The surface area of the probe head varies from tip to tip. The dimensions and design of this probe allow accurate placement within the nasal cavity with easy operation and recording of the probe tip deflection.

Pressure is calculated by dividing the force necessary to produce a specific deflection of the lever by the surface area of the probe head. The device was calibrated by suspending a series of weights from the probe tip and noting the deflection of the meter (which could be read to within plus or minus half a division).

* Received for publication September 17, 1992; accepted December 18, 1992

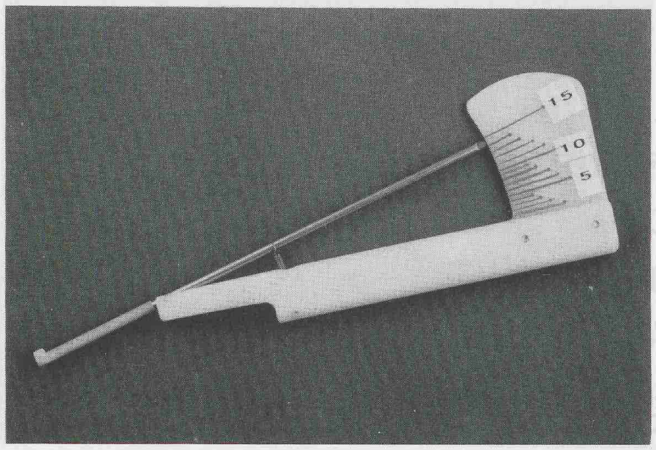

Figure 1. Photograph of the Sheffield Nasal Pressure Probe.

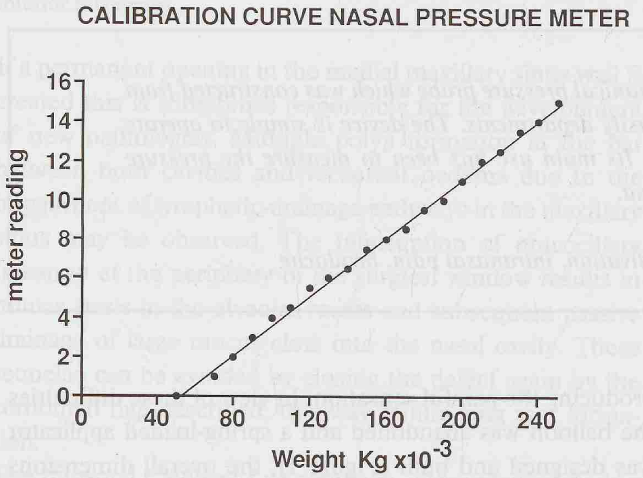

Figure 2. Calibration curve for the Sheffield Nasal Pressure Probe.

RESULTS

Figure 2 shows the relationship between applied weight and meter deflection. The calibration curve is linear with an initial offset. The relationship between the force applied and the resulting deflection is:

$$F = (A \cdot D + B) \cdot g$$

in which *F* represents force (in N); *D* is the meter deflection; *A* is a constant value (i.e., 13.75) obtained from the calibration graph; *B* is a constant value (i.e., 50), the initial offset of the calibration curve; *g* is the factor (i.e., 9.81) converting kilogrammes weight to Newtons. The maximum error is ±5% at any point on the scale. Knowing the force (F) required to produce a specific deflection for a constant probe-head area (a) which is also known, the pressure applied to the nasal mucosa can be calculated with the formula:

$$P = F \cdot a^{-1}$$

Initial studies on healthy volunteers showed the device was simple reliable and rapid in operation. Repeatable measures of pain thresholds could be obtained.

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