Rhinology, 25, 109–115, 1987

A new technique using a nasal cast for anterior rhinomanometry

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SUMMARY

A new method of sealing a pressure sensing tube into the nostril for anterior rhinomanometry is described. This involves the use of a nasal cast made from dental impression material. The results demonstrate that the nasal cast technique gives the same resistance values as the standard nasal tape technique.

Obstruction of one nostril with a nasal cast for fifteen minutes is shown to have no effect on nasal resistance. The advantages of the nasal cast method compared with the nasal tape method are described.

INTRODUCTION

Anterior rhinomanometry is the most commonly used method for clinical and scientific studies on nasal resistance to airflow, and since the publication of the nasal tape technique by Solow and Greve in 1980 the use of a nasal tape to seal one nostril for pressure measurements has become the standard technique of anterior rhinomanometry. The nasal tape seals the nostril without irritation of the nasal mucosa or distortion of the nasal valve area of the nostril. However there are some disadvantages associated with the use of nasal tape where several readings of nasal resistance are required, as repeated use of an adhesive tape can cause irritation of the nasal skin. A new set of tapes has to be made for each measurement of nasal resistance, and in subjects with a moustache it is difficult to obtain an airtight seal. Another problem associated with the nasal tape is that when high pressure values are encountered the ballooning out of the tape may cause a hysteresis in the nasal curve for pressure and flow.

In a clinical situation where single one – off measurements are required the tape method of sealing the nostril is adequate but when repeated measurements of nasal resistance are required for research on drugs, nasal challenge, or studies on the nasal cycle then the tape method becomes tedious and cumbersome.

We have developed another method of sealing the nasal passage by using nasal casts which are individually tailored to each subject. The nasal casts have proved extremely useful where repeated measurements of nasal resistance are required for research work.

In the present paper we provide results which demonstrate that the nasal cast and nasal tape technique give the same result and also demonstrate that the obstruc-

tion of one nasal passage with a nasal cast for a period of 15 minutes has no effect on nasal resistance to airflow.

METHODS

Subjects

Seven subjects, 3 female and 4 male (age 20–34 years) all healthy and clear of any nasal infection or allergy were used for the study.

Nasal resistance measurements

Nasal resistance was measured using the standard NR1 nasal resistance meter (Mercury Electronics, Glasgow, U.K.) with pressure values measured at a sample flow of 2.0 l/sec. The pressure sensing tube was sealed into the nostril either by means of an adhesive tape (Solow and Greve, 1980) or by means of a nasal cast. Each value of nasal resistance consisted of a mean of ten breaths. Two sets of breaths separated by a change in the position of the standard face mask (Mercury Electronics, Glasgow, U.K.). Usually the change in the position of the face mask did not alter the nasal resistance values obtained, but if there was any difference between the two sets of readings then repeat readings were taken until two consecutive and similar sets of readings were obtained. This procedure helped to eliminate the effects of any leakage around the face mask seal.

Nasal resistance values were calculated from the relationship:

$$Rn = P/V \text{ cm } H_2O/l/sec$$

where V = Nasal airflow (set at 0.2 l/sec)

and P = Transnasal pressure (cm H_2O)

Preparation of the nasal cast

Nasal casts were made from a silicone based dental impression material, Optosil (Bayer Dutch). A kneadable non-allergenic compound which in its inactive state has a soft dough-like consistency but becomes a hard durable compound when activated by a hardener (Elastomer Activator, Bayer). The inactive optosil was scooped in a plastic spoon and 5–6 drops of hardener (Elastomer Activator, Bayer) added to it. The two compounds were then kneaded together with the fingers. The activated compound, still soft, was then gently manipulated into the vestibule and made a tight fit without distorting the alae nasi. It was left in-situ for about 5–7 minutes and allowed to harden.

On hardening, the hard cast was removed and a hole drilled through its middle so that a canula could be sealed into the cast. A tube, 15.0 cm long of outer diameter 1.70 mm and inner diameter 1.19 mm was then inserted into the hole and one end was flared in a flame. The flared end was made flush with the proximal surface of the nasal cast and sealed into the cast by applying an adhesive (Supaglau-3,

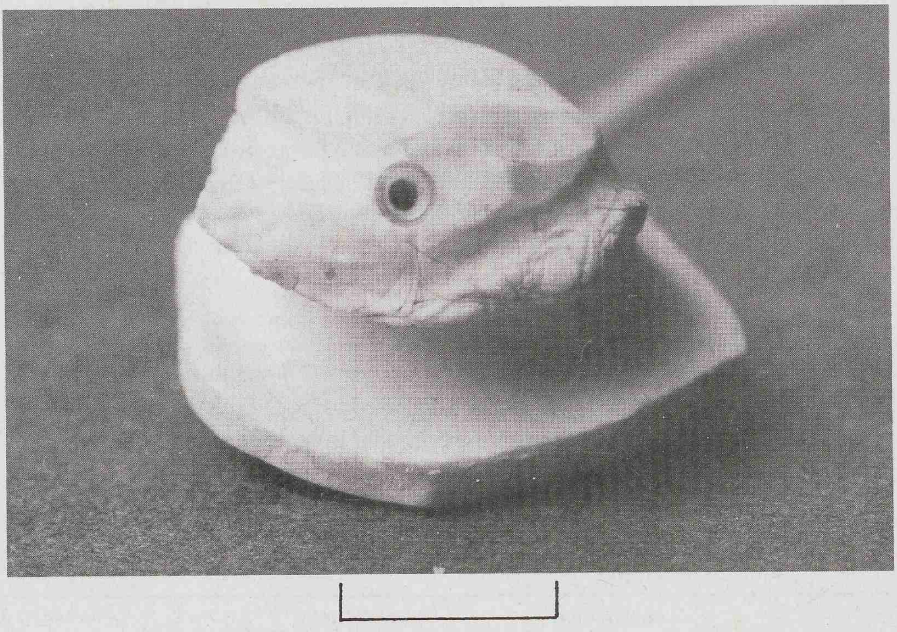

Figure 1. Photograph of nasal cast.

Loctite, U.K.) around the tube (Figure 1). The distal end was bevelled and connected to the nasal resistance meter NR1. The nasal cast of the vestibule was then placed back into the vestibule and checked for leakages around its edges. Whenever leakages occured around the nasal cast, it was usually necessary to build up the septal aspect of the cast and this together with a film of petroleum jelly (Vaseline) almost always provided a good seal in the vestibule.

Comparison of tape and cast methods

Nasal resistance measurements were made in seated subjects at rest by using first the tape method and then the nasal cast method with both sets of readings separated by no more than ten minutes. The short time interval between readings helped to eliminate interference from spontaneous changes in nasal resistance associated with the nasal cycle.

Unilateral nasal obstruction

The nasal cast technique was used to determine nasal resistance values at approximately five minute intervals for both nasal passages as described above. After a fifteen minute control period the nasal cast was left in the nasal passage with the

lowest nasal resistance to airflow (LC) for fifteen minutes so that all respiration took place through the nasal passage with the higher resistance (HC). During this period of unilateral obstruction nasal resistance measurements were only possible on nasal passage HC with the nasal cast in LC acting as a pressure sensor. After removal of the nasal cast from the nasal passage LC nasal resistance measurements were made again for both nasal passages over a further fifteen minute control period.

RESULTS

Comparison of tape and cast methods

Six of the subjects were used for thirteen experiments. No significant difference was found between the nasal resistance values obtained using the nasal tape or nasal cast techniques. The pooled results of the experiments are shown in Table 1.

Table 1. Comparison of nasal resistance values obtained using either nasal tape or nasal cast techniques. Each value represents a mean value of 13 experiments on 6 subjects + S.E.M.

	nasal tape method cm H_2O/l/sec	nasal cast method cm H_2O/l/sec	paired *t* test *P* value
high resistance passage (HC)	10.01 + 1.6	10.53 + 1.51	$p > 0.5$
low resistance passage (LC)	3.95 + 0.56	3.97 + 0.49	$p > 0.9$
total resistance (calculated)	2.57 + 0.29	2.61 + 0.23	$p > 0.8$

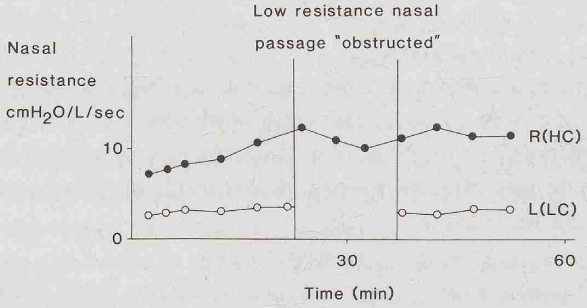

Figure 2. The changes in nasal resistance caused by fifteen minutes obstruction of one nasal passage (LC) with a nasal cast. Each point represent a mean value of nasal resistance for ten breaths. (R), (L) right and left nasal passages. (HC), (LC) high and low resistance nasal passages under control conditions at start of measurements.

Unilateral nasal obstruction

Seven subjects were used for these experiments and a typical example of one experiment is shown in Figure 2, which illustrates the nasal resistance values for both nasal passages before and after fifteen minutes obstruction of nasal passage LC. The period of unilateral obstruction of nasal passage LC had no effect on the resistance of the nasal passages when measured before and after the obstruction. Similarly the resistance of nasal passage HC was unaffected during the obstruction of LC. The pooled results of the experiments are shown in Table 2.

Table 2. Comparison af nasal resistance values before and after 15 min obstruction of the lower resistance nasal passage LC with a nasal cast. All measurements taken using nasal cast technique. Each value represents a mean value of 7 experiments on 7 subjects + S.E.M.

	before obstruction of nasal passage cm H_2O/l/sec	after 15 min obstruction of nasal passage LC	paired *t* test *P* value
high resistance passage (HC)	15.56 + 2.24	16.66 + 2.4	$p > 0.4$
low resistance passage (LC)	3.59 + 0.70	3.94 + 0.71	$p > 0.1$
total resistance (calculated)	2.68 + 0.38	2.95 + 0.36	$p > 0.1$

DISCUSSION

Comparison of the nasal cast and tape

The results clearly demonstrate that there is no significant difference between the nasal resistance values obtained when using either a nasal cast or nasal tape to determine transnasal pressure. Therefore the nasal cast provides a very useful alternative to the nasal tape for repeated measurements of nasal resistance.

The manufacture of nasal casts for a subject only takes around fifteen minutes and once made they last indefinitely. Many casts have been in regular use for over three years in our laboratory without any sign of wear or deterioration and the only indication for the manufacture of new casts for a subject is a change in the structure of the nasal vestibule due to surgery or trauma.

The advantages of the nasal cast over the nasal tape are firstly that repeated measurements are more rapid and secondly that leaks due to moustache or poor fixation are less likely with the cast. The nasal cast can easily be inserted by the subject and this speeds up the procedure and allows one person to perform self readings of nasal resistance. The superiority of the cast over the tape is most apparent when serial measurements of nasal resistance are to be made, for example six or so readings over an hour on a group subjects, perhaps repeated at daily in-

tervals. Once the casts have been made for a group of subjects they can be used repeatedly over several years.

Another extra bit of information the casts provide is a precise impression of the nasal vestibule and this anatomical piece of information may be of use in studying nasal physiology and pathology, and could also provide useful information to the surgeon who intends to operate on this area of the nose.

The nasal cast provides an exact and rigid seal of the nasal vestibule and reduces any hysteresis which may be apparent when using the nasal tape at high pressures.

The nasal cast is also very useful in experiments where the subject is required to exercise or change posture as it is far less likely to be disturbed than the nasal tape, and it is unaffected by sweat or oily secretions of the nasal skin.

If manufactured correctly the nasal cast should not touch the nasal mucosa and in our experience careful insertion of the cast does not cause any nasal irritation. The dental impression material is non toxic and non allergenic and we have not observed any reactions to the impression material or hardener.

Unilateral nasal obstruction

The results demonstrate that unilateral nasal obstruction with a nasal cast for fifteen minutes has no significant effect on nasal resistance. This is an important point for both the tape and cast techniques, as in anterior rhinomanometry the total nasal airflow is diverted through only one nasal passage during the period of nasal resistance measurement and the change in nasal airflow and resistance could induce a reflex change in nasal resistance. These results agree with those of Haight and Cole (1983) who found that unilateral obstruction for ten minute periods did not cause any change in nasal resistance.

The present study therefore describes a useful alternative method of sealing a nasal passage for pressure sensing with anterior rhinomanometry. The nasal cast method has proved a useful and reliable method in our laboratory and further studies will determine if it proves to be of benefit to other workers interested in measuring nasal resistance to airflow.

ZUSAMMENFASSUNG

Es wird ein neues Verfahren beschrieben, das es ermöglicht, ein Druckmessröhrchen zum Zweck einer vorderen Rhinomanometrie luftdicht in ein Nasenloch einzufügen. Hierbei kommt ein Nasenausguss aus Zahnabdruckmaterial zur Anwendung. Es liess sich nachweisen, dass dieses Nasenausgussverfahren die gleichen Widerstandswerte ergibt wie das herkömmliche Nasenverschlussverfahren, bei dem ein Pflaster verwendet wird.

Es konnte gezeigt werden, dass ein fünfzehn Minuten dauernder Verschluss eines Nasenlochs keinen Einfluss auf den Nasenwiderstand hat. Es werden

die Vorteile dieses Nasenausgussverfahrens im Vergleich mit dem Nasenpflasterverfahren beschrieben.

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