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ORIGINAL ARTICLE

Nasal Strips for Evaluating and Classifying Valvular Nasal Obstruction

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Abstract
Background A normal-appearing upper lateral cartilage (ULC) or lower lateral cartilage (LLC) may be functionally abnormal. The Cottle sign estimates obstruction but not its exact location. A test is needed that evaluates the ULC and LLC separately.
Methods The study included 30 patients with airway obstruction symptoms and signs referable only to the nasal valves. They received a Cottle test and a Breathe-Rite nasal strip to the middle third of the nose and again to the lower third (the rims). The patients were asked whether the strip made their inspiration better, worse, or no different and classified as BR 0 (no airway obstruction due to ULC/LLC dysfunction), BR I (improvement with the strip on the ULC), BR II (improvement with the strip on the LLC), or BR III (improvement with strips on both the ULC and the LLC, independently). All the patients underwent surgery involving spreader grafts, lateral crural struts, suture techniques, and the like. Correlations were sought between the BR classification, Cottle sign, and physical integrity of the ULC/LLC.
Results A total of 12 patients required internal valve correction, whereas 8 required external valve correction, and 10 required correction of both. The Cottle test was nonspecific because most patients in all the groups exhibited a positive Cottle. However, the BR classification was specific, correlating with functional outcomes for 27 of the 30 patients. The McNemar test showed a significant correlation ($X^2 = 9.09091$; $P = 0.00257$) between physical finding and BR score.
Conclusions Inspiratory nasal function (related to ULC/LLC cartilages) is easily classified using nasal strips. The BR test is more specific and powerful than the Cottle test.

Keywords Breathe-Rite · Cottle test · External valves · Inspiratory obstruction · Internal valves · Nasal strips · Nasal valves

Valvular nasal airway obstruction is arguably as important a cause of nasal airway obstruction as septal and turbinate deformities if not more important [1]. This has prompted many surgeons [2–7] to devise a variety of procedures to treat the problem if it can be diagnosed.

Preoperative evaluation of valvular dysfunction usually is based on gross examination of the internal and external valves (narrowness or weakness of the middle third of the nose; deformity or weakness of the alar rims) in conjunction with a diminution of inspiratory air flow. The Cottle test allows for an opening of these valves to see what improvement results by spreading the lateral nasal walls apart. In terms of predicting the benefit of valvular reconstruction, it is a good test in that it provides a functional evaluation of the valves. This is particularly important when the valves are not obviously deformed as noted by inspection and palpation. However, it is inaccurate because it is not specific for any one valve. The examining thumb is as wide as the entire nasal wall.

The modified Cottle test [8, 9], which involves insertion of a cotton applicator inside the nose to elevate the lateral nasal wall, is a much improved version of the original test

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in that it can be specific for one side or the other, and it can even be specific for the internal or external nasal valve. However, it is an uncomfortable test for evaluating the valves, especially the internal valve. Like the Cottle test, it is not quantitatively accurate in that the result is dependent on the pressure exerted by the examiner.

As a result, there have been many cases in which the middle third of the nose was thin, suggesting that reconstruction with spreader grafts would be helpful when in fact airflow was adequate to begin with. Conversely, there have been other cases in which the external valves (alar rims) seemed sufficient for palpation, and yet a Cottle test suggested otherwise. Thus, the alar rim may appear collapsed and yet show a negative Cottle test result. The net result is that in many cases, the clinician cannot be certain that correction of the valves is necessary and that such correction will provide adequate relief.

A functional test is needed that evaluates the internal and external valves separately, gives consistent values on repeat measurements, and provides reproducible results among different examiners. Finally, the test should give some predictive value to valvular reconstruction.

For many years, external nasal dilator strips have been popular for improving the airway of patients who, for one reason or another, do not receive surgical correction of their valvular obstruction. Athletes also use these strips to increase their nasal airflow even if oxygenation is not necessarily increased. Logic suggested that the nasal strip could be a simple functional test for valvular nasal obstruction.

Experiment 1

Methods

The study included 30 patients with symptomatic valvular disorders but no major septal or turbinate pathology. The patients with septal or turbinate pathology as a contributor to airway obstruction were excluded from the study so that valvular function alone could be studied. There were 22 females and 8 males ranging in age from 17 to 53 years. The follow-up period was 10 to 23 months. Their physical findings in terms of internal and external valve structure were evaluated by inspection and palpation. Inspiratory airflow was evaluated by the traditional Cottle test and airway function using the Breathe-Rite strip (GlaxoSmithKline, Middlesex, Great Britain).

The patients were told to state whether the nasal strip provided a better airway, a worse airway, or no change. The skin of the nose was wiped with alcohol. A Breathe-Rite strip was applied to the middle vault just caudal to the nasal bones in the region of the upper lateral cartilage (ULC). The patient's response was prompted.

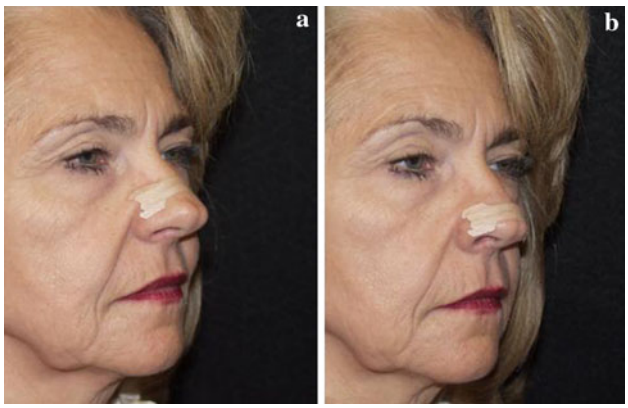

Fig. 1 **a** After the skin has been wiped with alcohol, the nasal strip is applied to the middle third of the nose. The patient is asked if it helps, hinders, or has no effect on his or her airway. **b** A new strip is applied to the lower third of the nose over the alar rims, and the same question is asked

The strip was removed, and a new one was applied to the lower third of the nose in the region of the lower lateral cartilages (LLC), including the alar rims. Again, the patient's response was prompted (Fig. 1).

The patients were asked which strip improved the airway more: the upper one or the lower one. The application order was randomized and reversed for half of the patients. Subsequent to this study, generic nasal strips were used and found to be as good as the proprietary one or better. The patients were classified as BR 0 (no airway obstruction due to ULC/LLC dysfunction), BR I (improvement with the strip on the ULC), BR II (improvement with the strip on the LLC), or BR III (improvement with the strips on both the ULC and the LLC, independently).

The decision as to the type of valvular correction was based on the physical findings (e.g., pinched tip, inverted V, valves weak to palpation, Cottle test, and BR classification). Of the 30 patients, 20 required associated aesthetic corrections of the nose (e.g., osteotomy, nasal tip rotation, and hanging columellar correction), procedures not related to valvular dysfunction. Postoperatively, the patients were again evaluated in terms of subjective symptoms, physical structure of the valves, the Cottle test, and the BR score.

Results

Preoperatively, all 30 patients exhibited significant symptomatic valvular obstruction. All 30 received valvular surgery (internal valve surgery for 12, external valve surgery for 8, and surgery to both valves for 10 patients). Of the 12 internal valve patients, 10 exhibited obvious physical findings of a valvular deformity (e.g., inverted V, marked weakness to palpation). A positive Cottle was exhibited by 11 of the 12 patients. Of the 12 patients, 11

were classified as BR I, 0 as BR II, and 1 as BR III (Fig. 3). For these patients, 11 spreader grafts and 1 splay graft were performed.

Six of the eight external valve patients exhibited obvious abnormal physical findings of a valvular deformity (e.g., pinched tip, collapsed rims). Seven of the eight exhibited positive Cottle test results. Seven of the eight were classified as BR II, one as BR III, and none as BR I (Fig. 3).Two lateral crural struts, three rim grafts, one lateral crus replacement, and two suture restoration procedures were performed. Obvious physical findings of a valvular deformity were shown by 7 of the 10 internal/external valve patients, and 9 of the 10 exhibited positive Cottle test results. Of the 10 patients, 9 were classified as BR III, 1 as BR I, and 0 as BR II (Fig. 4). Multiple procedures were required including rim grafts and spreader grafts.

All 30 patients exhibited symptomatic improvement of their airway. However, 2 of the 30 felt that the improvement was less than they had hoped to obtain, but they did not opt for further surgical correction. As can be seen in Figs. 2, 3, and 4, the Cottle test was nonspecific because most patients in all the groups exhibited positive Cottle results. However, the BR was specific, correlating with functional outcomes for 27 of the 30 patients. Because the BR classification was used as part of the decision-making process, a statistical analysis between the BR classification and the type of valvular dysfunction found at surgery could not be performed. However, it was possible to make a statistical correlation between the physical finding, the Cottle test, and the BR classification. The McNemar test was used for this purpose.

The McNemar test is used to examine the difference between paired proportions (e.g., in studies with patients serving as their own control or in studies with a "before and after" design. It showed a significant correlation ($X^2 = 9.09091$; $P = 0.00257$) between BR and physical finding. No significant association between physical finding and Cottle test result was shown.

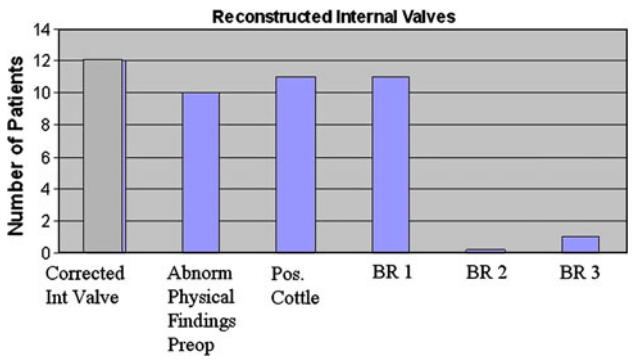

Fig. 2 Distribution of findings among patients who had isolated internal valve surgery. Note that almost all the patients were Cottle-positive and classified as BR I preoperatively

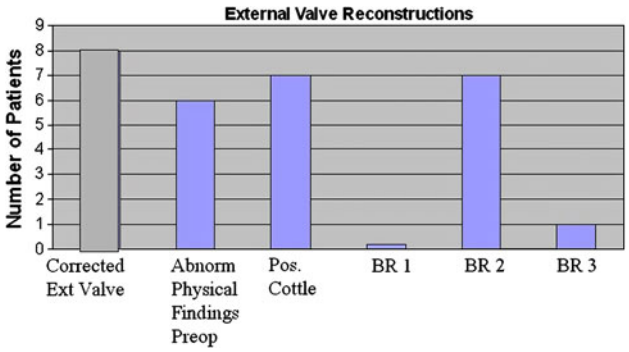

Fig. 3 Distribution of findings among patients who had isolated external valve surgery. Note that most of the patients were Cottle-positive and classified as BR II

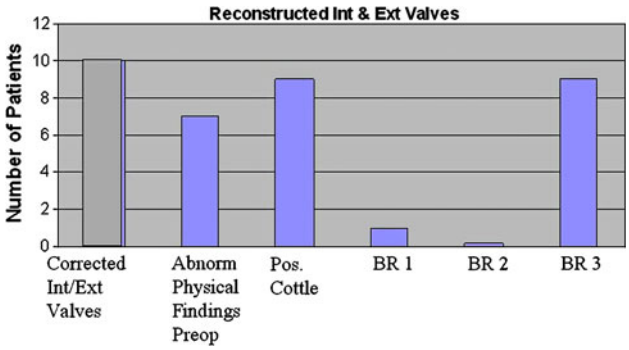

Fig. 4 Distribution of findings among patients who had both internal and external valve surgery. Note that most of the patients were Cottle-positive and classified as BR III

Experiment 2

Methods and Results

A group of 16 patients who had undergone other non-nasal cosmetic procedures and presented as nasally asymptomatic were evaluated. Physical examination of the nasal valves, the Cottle test, and the nasal strip test were performed as in Experiment 1. Six patients exhibited abnormal internal or external valves at examination. Four patients exhibited positive Cottle test results. However, 12 patients noted an improved inspiration with the nasal strip. Of the 12 patients, 6 were classified as BR I, 1 as BR II, and 5 as BR III (Fig. 5).

Discussion

The Cottle test is a nonspecific indicator of valvular obstruction, whereas the nasal strip test is more specific.

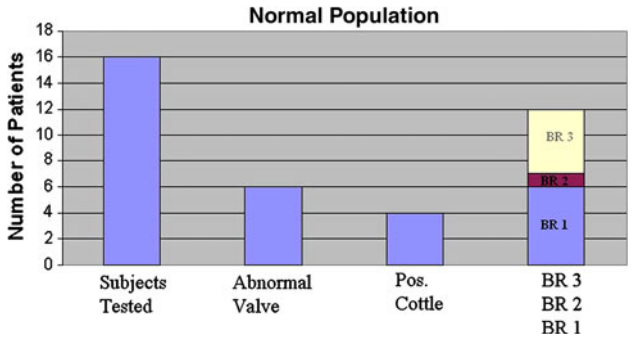

Fig. 5 Distribution of findings among a sample of the normal population (asymptomatic patients seeking non-nasal cosmetic surgery). Note that some exhibited abnormal valves at examination, and some exhibited positive Cottle test results. The nasal strip improved the airway for a significant number of the asymptomatic patients

The nasal strip test is a functional test. It is especially helpful in cases in which it is not obvious at the physical exam that the valve is collapsed. For example, the middle third of the nose may appear normal and show no abnormality at palpation although the nasal strip suggests otherwise. The nasal strip test also is helpful in those few cases that do not show improvement of an apparently collapsed or dysfunctional valve with use of the nasal strip. In these cases, the nasal strip test should be a warning to the surgeon that surgical correction of the valve may not produce the desired result and that he or she should be looking elsewhere for a solution to the airway problem.

The normal population [10, 11], perhaps excepting the African-American population in one study [12], is known to be improved by nasal strips. The valvular function of most people is not necessarily abnormal, yet they subjectively experience improved airflow with the nasal strips. Athletes frequently use these strips to increase their nasal airflow. In some studies (including those with cadavers) [13], the nasal strip increased mean nasal cross-sectional area by 17 to 37% [14, 15] and airflow by 27% [15]. The results of experiment 2 confirm studies showing that nasal airflow is improved in a significant portion of the normal population.

Some of the normal population may have unrecognized or asymptomatic valvular problems. More likely, much of the population may exhibit a benefit from nasal strips by achieving a greater than normal nasal airflow. It could be argued therefore that much of the improved results with nasal strips seen in the patients of Experiment 1 are not reflecting abnormal valvular function but simply increasing airflow to aforementioned normal values. That may very well be, but this does not detract from the fact that as a functional test, it predicts which valve will benefit from surgical correction. Interestingly, the subjective airflow of normal patients was increased more by the BR test than by the Cottle test, indicating that the nasal strip is a more powerful test than the examining fingers.

To prove conclusively that the BR classification leads to a better diagnosis and outcome, it would have been necessary to exclude the BR classification from the decision as to which valve should receive surgery. Ideally, a study should base the surgical decision on the physical findings and the Cottle test alone. Then the clinician would correlate the successful outcome with the BR classification it was given.

However, early in the study, it was readily apparent that the functional nasal strip test was so superior to the Cottle test and provided such vital information as to which valve should receive surgery that it was impossible to ignore it and subject the patient to surgery without using that information.

Nasal airway obstruction can result from other causes (septal deformities, turbinate hypertrophy, drooping nasal tip) that cannot be evaluated by the BR test. It is reasonable to ask whether the BR test is useful when these other pathologies coexist, and they often do. The answer is yes, with few exceptions.

Septal deformities and turbinate hypertrophy tend to obstruct expiratory flow, which we test for separately. Unless the septal or turbinate deformity is almost completely occluding the vestibule, the patient is almost always able to inspire to some degree. That amount of inspiration will be enhanced if in fact the damaged valve or valves are opened further by the nasal strip.

One caveat is in order, however. When septal deviation is severe, a false-positive test can be expected. Under those circumstances, the valve on the obstructed side is closer to the septum, and (by Bernoulli's principle) collapse of the valve is more likely to occur. Correction of the septal deviation alone without valvular correction then would be expected to reverse a positive BR. However, severe septal deviations of this kind are in the minority. The BR test will be helpful in the vast majority of cases.

It is of interest that the BR test proved to be more specific than the Cottle test. That probably is because the force of the examining fingers to open the nose is at the cheek level only. On the other hand, the nasal strip expands the actual side walls of the nose (Fig. 6). It is more specific because it is narrower than the fingers and can be applied directly either to the middle third of the nose or along the alar rims. Dr. Cottle's test is an ingenious, quick way to evaluate overall valvular function. The BR test is simply an improvement.

Conclusions

Inspiratory nasal function (related to ULC/LLC cartilages) is easily evaluated and classified by using nasal strips. The BR test is more specific and powerful than the Cottle test.

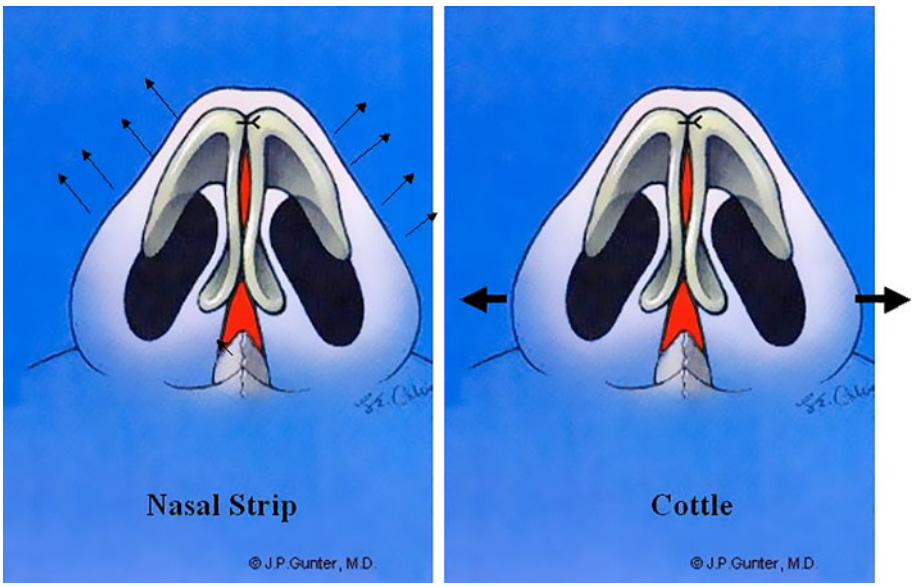

Fig. 6 In the Cottle test, the force of the examining fingers to open the nose is at the cheek level only. On the other hand, the nasal strip expands the actual side walls of the nose, showing why it may be not only a more specific test of valvular function but also a stronger test

The external nasal dilator strip is helpful when the clinician is not certain whether the valve is the cause of airway obstruction. In effect, it is a mock surgery.

Conflict of interest None.

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