Rhinology, XV, 73-79, 1977

A clinical evaluation of the Cottle rhinomanometry "flow" nozzle

Charles A. Tucker, Hartford, U.S.A.

SUMMARY

A clinical study was undertaken to establish what changes in values were caused by the nozzle used in the Cottle flow-pressure technique of rhinomanometry. Cottle rhino-sphygmo-manometry was performed over seven hundred times, half with the nozzle and half without and the results analyzed using pattern, rate, amplitude, work co-efficient and four breath factor as outlined by Cottle. In many instances marked changes did occur but were unpredictable by examination prior to testing. It is suggested that Cottle rhino-sphygmo-manometry be carried out routinely with and without this nozzle in order to better evaluate results of flow-pressure relationship in which this nozzle is used.

THE Cottle (1968) method of anterior rhino-sphygmo-manometry remains the most practical method of office testing for the practicing rhinologist and continues to provide major contributions in the evaluation of human disorders in which the nose and paranasal sinuses have a role. Valuable information has been available in the recording of amplitude, rate and pattern of nasal breathing.

This method has been valid despite the use of an anterior nozzle for two reasons. The first is that the nozzle is applied to the nostril of the side of the nose opposite to that being tested. Secondly, the opening may be small because it is measuring pressure only and, therefore, nozzles may be constructed which conform to the underlying anatomy.

This also applies to a great extent to the Cottle revma-sphygmo-manometry since here, too, a 5 mm. diameter opening has been selected permitting a wide choice of nozzle shapes. Accurate-reproducible findings are usually possible and are reliable with the exception of marked distortion in area 1, the nasal vestibule, especially in a slitlike nostril.

In the Cottle method of measuring flow, however, a nozzle must be used the bore of which is at least as large as the hydraulic cross section of the normal adult nasal fossa. This requires a nozzle which, if the opening is round, must be at least 8 mm. in diameter. The use of this nozzle frequently causes distortion of the nostril and may alter the relationship of the lobular (lower lateral) and upper

Presented at the 22nd Annual Meeting of the American Rhinologic Society,
Las Vegas, Nevada, October 2, 1976.

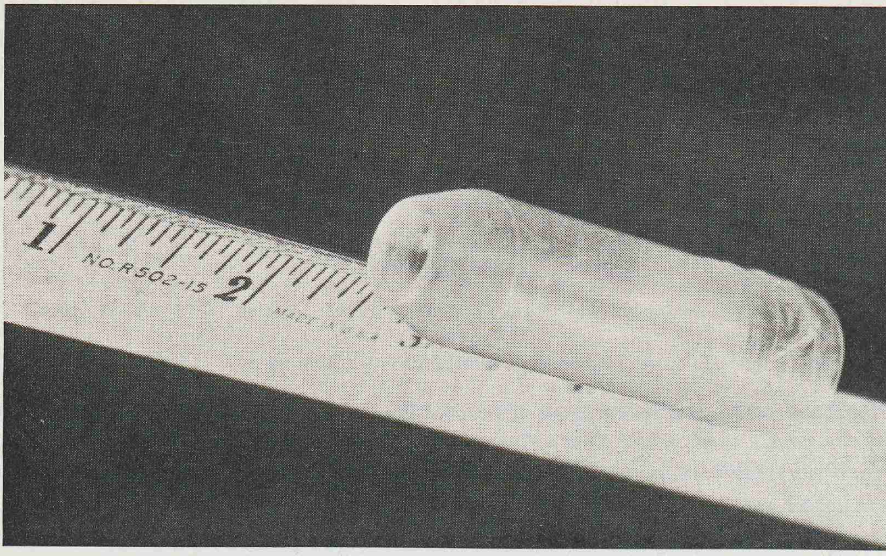


Figure 1. The Cottle standard "flow" nozzle.

lateral cartilages one to another and to the septum and may cause other changes that affect resistance to air flow. This includes area one, the area of the nasal vestibule, area two, the os internum or nasal valve and at times changes involving nasal structures more posteriorly.

At an American Rhinologic Seminar led by Doctor Cottle in Chicago in June of 1975 on rhinomanometry several questions were asked. How should nozzles be applied? What shape should they be? Was this important? Most of these questions were unanswered. It was stated that the nozzle with an eight mm. diameter opening used for flow-pressure tests distorted areas one and two and that such flow-pressure relationships measured in this manner were actually an indication of what occurred in areas three, four and five. Published documentation backing up this statement cannot be found.

Nakano (1967) working out of van Dishoeck's Clinic reported in 1967 a study of various types of nozzles used in anterior rhinomanometry. He described three types of nozzles — nostril, rim and vestibular. He drew certain conclusions from testing each of these on the artificial nose and on the live human. Although one cannot always agree with his conclusions, he does point up changes which nozzles may bring about by their configuration and how they are applied to the nose. It has been known that the "speculum test" used by many and reported by Montserrat in 1967, causes considerable change in pressure curves. This test consists of inserting a nasal speculum into the side of the nose being tested and spreading the valve area. These findings compared with testing without the speculum are thought by many to be helpful in differentiating between resistance in areas one and two and the remainder of the nose. Rhinomanometry performed after shrinkage of the mucosa, including the turbinates, may be performed to rule out some of the mucosal factors and may delineate somewhat more accurately resistance caused by structure alone.

The present investigation consisted of testing the nasal pressures on one side of the nose as in the standard procedure with Cottle's rhino-sphygmo-manometry and then was repeated by testing of pressure but with a flow nozzle inserted into the side of the nose being tested. This nozzle was the same as is used in the Cottle method of testing flow-pressure relationships and will be referred to hereafter as the "flow" nozzle, (Figure 1). Graphs were obtained in each instance and compared to determine if and how much alteration in findings occurred. Criteria of rate, amplitude, pattern, work co-efficient and four breath factor were chosen for analysis to determine differences and, if any occurred, to correlate them with the anatomy and pathology present. Cottle (1968) has said that changes in work co-efficient and four breath factor more or less reflect what is going on in the nose.

Over seven hundred tests were performed on adults between the ages of thirteen and eighty-three. They were about equally divided between the sexes. They did not necessarily represent patients with nasal complaints or demonstrable nasal pathology. Some tests were performed with shrinkage of the nasal mucosa and some without. No tests were excluded from this series except those where obstruction was so great that it could not accurately be measured with the equipment being used. Consistency was frequently checked by repeated testing.

The equipment was the unmodified ICS Cottle nasal pressure flow recorder, Model ≠ PF 102, which was calibrated at weekly intervals.

Insertion of the nozzle was of great importance as in the standard procedure. The nozzle shaft should be more or less parallel with the nasal dorsum and should not deviate from side to side or up and down. It must be inserted gently and yet forcibly enough to prevent air escaping around it. This requires greater pressure in certain nostrils than in others. In none of the tests herein reported was a nostril found so small that it could not admit the tip of the nozzle. Such nostrils obviously do occur but other means of testing must be used in performing that type of rhinomanometry.

Analyses of the results were as follows and represent the raw data on over five hundred tests, (Figure 2). The rate of breathing without insertion of the nozzle was 15.5 and with the nozzle was 15.7. This slight difference is thought to be

	Without "Flow" Nozzle	With "Flow" Nozzle
Rate of breathing per minute	15.5	15.7
Average amplitude of inspiration in mm. of water	18.6	14.8
Work co-efficient	266.4	224.7
4 breath factor	312.4	230.2

Figure 2. Analysis of over 700 tests of anterior rhinomanometry without and with a "flow" nozzle inserted in the side being tested.

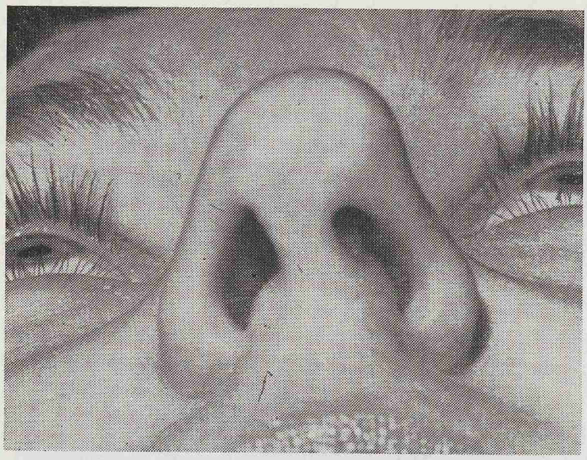


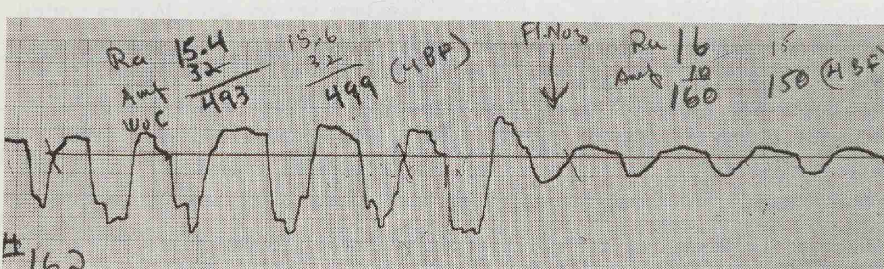
Figure 3. A narrow left nostril.

statistically insignificant. The average amplitude of inspiration in mm. of water was 18.6 without the nozzle and 14.8 with the nozzle. The work co-efficient without the nozzle was 266.4 and with the nozzle 224.7. The four breath factor was 312.4 without the nozzle and 230.2 with the nozzle.

For the most part pattern was not changed markedly except for decrease in amplitude, but in some instances change did occur and was found to be consistent by repeated testing. When a mid-cycle rest was present, it was usually better seen when the nozzle was inserted than when it was not, at least when a decrease in amplitude accompanied it. In like manner an occasional "flat top" was discovered. So much for the raw data.

An analysis of tests on patients having little or no visible pathology in general showed a lowering of values to a moderate extent for amplitude, work co-efficient

Figure 4. Rhinosphygmogram in a slit-like nostril.
WoC is work co-efficient (amplitude of inspiration in mm. of water times rate of respiration per minute). 4 BF is 4 breath factor (amplitude of inspiration in mm. of water times the number of seconds for 4 breaths). FINoz represents the time at which the flow nozzle was inserted with the graph showing a marked decrease in values thereafter.
The WoC was reduced from 493 to 160, the 4 BF from 499 to 150.



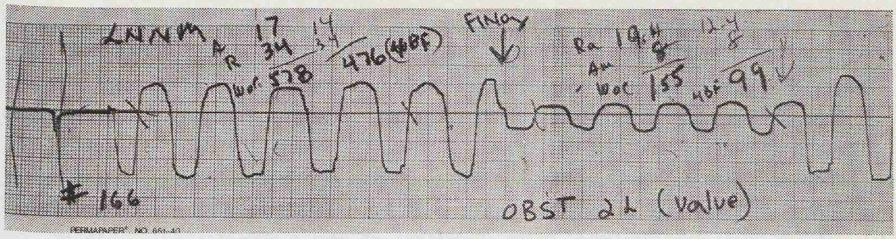
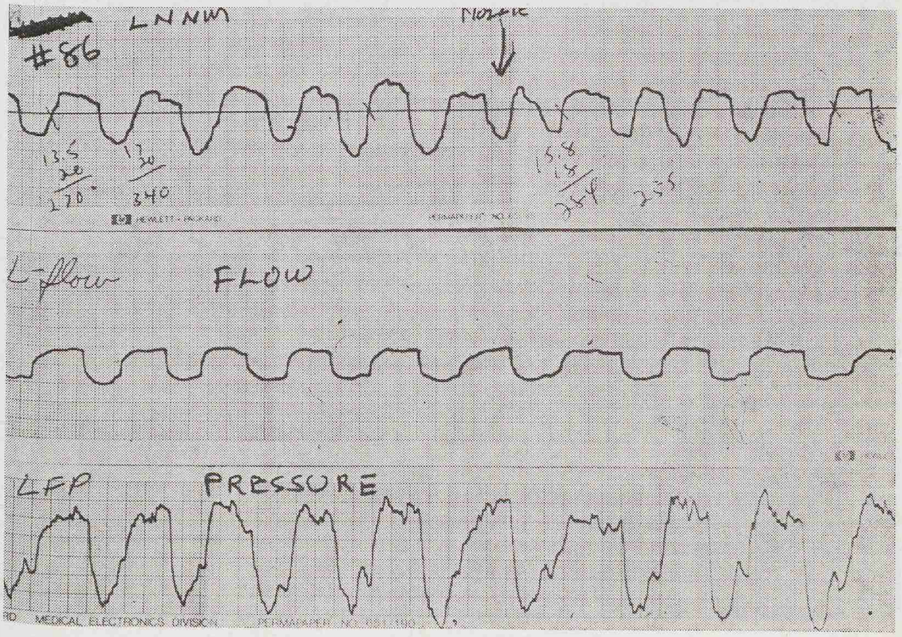


Figure 5. A reduction in the WoC from 578 to 155 and the 4 BF from 476 to 99 occurs with the insertion of the "flow" nozzle which opened a narrow valve.

and four breath factor. A somewhat greater drop was seen in noses which had roomy nasal fossae and this would agree with Nakano's results. The greatest drop occurred when marked pathology was present in area one such as the slit-like nostril, (Figures 3 and 4). The degree of narrowness had to be considerable before this occurred confirming Cottle's repeated observations.

Pathology in area two produced aberrations of many kinds. At times there was no decrease in values but at other times a marked decrease occurred apparently from spreading of the valve area quite similar to the use of a nasal speculum, (Figure 5). In others, marked increase in invalues were found. These occurred from generalized thickening of tissues such as one might find in patients recently

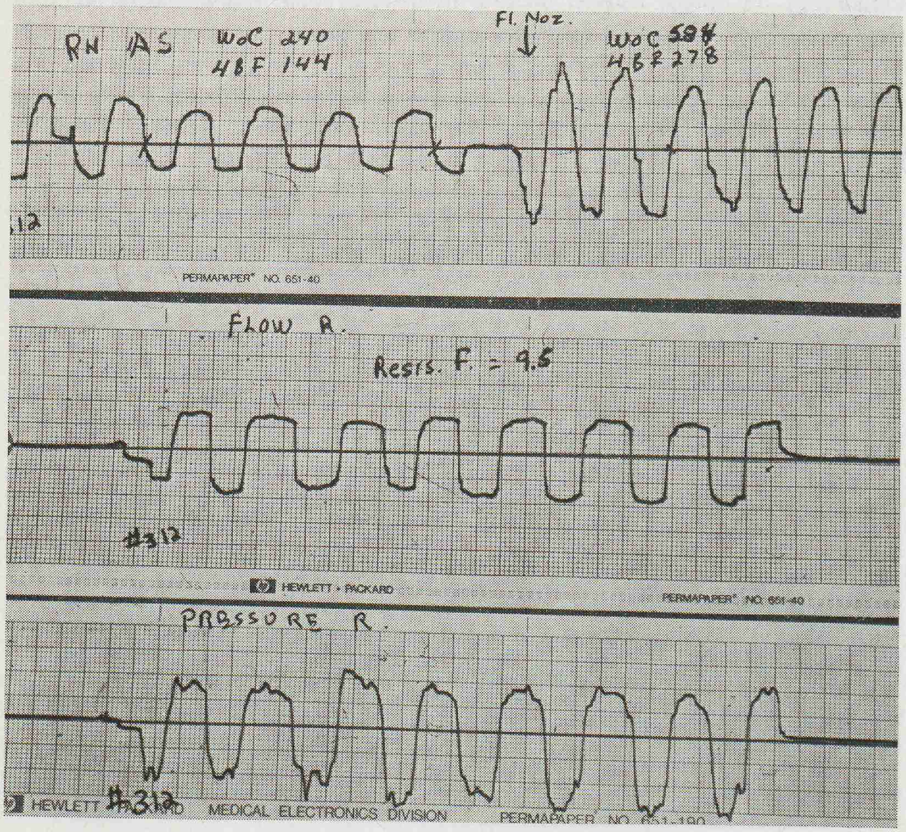
Figure 6. The top graph represents anterior rhinomanometry showing but little change after insertion of the "flow" nozzle. The two lower graphs represent a simultaneous flow-pressure study in which there is represented marked increase in resistance, valid because the "flow" nozzle has but litte effect.



operated upon or when there was a deformity present characterized by dislocation of the quadrilateral cartilage off the crest of the premaxilla to the affected side. Sometimes a markedly hypertrophied obstructing premaxilla was present. It was felt that the actual opening of the nozzle was compromised in such instances causing this marked increase in values or possibly turbulence was present in the region of the nozzle opening. In no instance was this increase in values thought to be due to turbinate obstruction and in a few tests where this was suspected, the values were not diminished by shrinkage of the turbinates.

It would seem, therefore, that evaluation of flow-pressure relationships with testing which includes the use of this nozzle, must be judged as to accuracy of results when values are changed significantly. It is difficult to judge this by inspection alone even by an experienced examiner. If there is but little change in the amplitude, work co-efficient and four breath factor or if the values are

Figure 7. The upper graph represents anterior rhinomanometry with an increase in values following the insertion of the "flow" nozzle. The two lower graphs represent increased resistance in the same patient when flow and pressure are recorded simultaneously. This may be largely due to the use of the nozzle making the resistance factor 9.5 when 6 is normal for this apparatus.



lower with the nozzle than without the nozzle, then flow-pressure tests showing increased resistance are significant, (Figure 6). If, however, the values are increased one must judge the flow-pressure relationship and resistance factor accordingly, (Figure 7).

CONCLUSIONS

(1) Definite changes in amplitude, work co-efficient and four breath factor and sometimes the rate and pattern of breathing may be brought about by the use of the "flow" nozzle in the side of the nose being tested by Cottle rhino-sphygmo-manometry. (2) Since this "flow" nozzle is utilized in determining flow-pressure relationship (and hence conductivity or resistance), the effect of this flow nozzle should be determined by the inclusion of an additional test with this nozzle in the Cottle rhino-sphygmo-manometry. Such a determination will make interpretation of the flow-pressure relationship more meaningful.

RÉSUMÉ

Une étude clinique a été entreprise afin de déterminer le changement des valeurs attribuable à l'olive narinaire dont on se sert avec la technique de pression-débit, en rhinomanométrie à la manière de Cottle. La rhino-sphygmomanométrie de Cottle a été utilisée plus de 700 fois; la moité en se servant de l'olive et l'autre moitié sans celle-ci, et les résultats ont été étudiés en tenant compte du type de tracé, du taux, de l'amplitude, du coéfficient de travail et du "facteur quatre respirations" tel que décrit par Cottle. Dans plusieurs cas, on a noté des changements remarquables, mais ceux-ci étaient imprévisibles lors de l'examen clinique fait avant l'évaluation rhinomanométrique. Il est suggéré de proçéder à la rhino-sphygmomanométrie de routine avec et sans cette olive narinaire, afin de mieux évaluer les résultats de la relation pression/débit lorsqu'on se sert de cette olive.

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Charles A. Tucker, M.D.,
100 Retreat Avenue
Hartford, Connecticut 06106,
U.S.A.