Rhinology, 37, 141–142, 1999

Acoustic rhinometry optimised for infants*

Per Gisle Djupesland

Department of Otorhinolaryngology, Ullevål University Hospital, University of Oslo, Norway

BACKGROUND

The nasal airway is the natural and preferred respiratory route at all ages. Oral breathing complements or replace nasal respiration only if the nasal ventilation becomes insufficient. The elevated position of the larynx in infancy, which enhances suckling and prevents aspiration, will impede conversion to oral breathing in case of nasal obstruction. Thus, both congenital and acquired nasal obstruction may cause severe, life-threatening respiratory distress in neonates and has been associated with the sudden infant death syndrome (SIDS). Despite the obvious deleterious impact of upper airway obstruction in infancy, investigative modalities suitable for assessment of upper airway patency have been limited.

Acoustic rhinometry (AR), introduced a decade ago for objective assessment of the nasal airways of adults, provides a description of the nasal airway geometry (figure 1). This simple, rapid and non-invasive acoustic technique has several attractive features relevant to application in a paediatric population. In fact, the smaller nasal dimensions of infants actually represent an advantage rather than a limitation. Encouraged by such technical and clinical considerations, RhinoMetrics a/s in Denmark, developed the optimised infant sound-wave tube on which this thesis is based.

OBJECTIVES

The initial and prime aim of this project was, and still is, to elucidate the potential role of nasal obstruction in apnoea, SIDS and other paediatric airway pathologies. Due to the novelty of this technique a thorough validation of its abilities and limitations was required. Furthermore, normative values for nasal airway dimensions in infancy had to be established to permit reliable interpretation of the clinical results.

MAIN RESULTS

The first study included in this thesis (paper I) demonstrates that the repeatability, reproducibility and accuracy of the rhinometric measurements in the tubular models are high, provided the absolute and relative dimensions respect certain limits which are defined by the characteristics of the sound-wave tube and the sound source. Secondly, insertion of rods to simulate the slit-like shape of the nasal passages in vivo did not reduce the accuracy of the measurements, which is essential to the clinical applicability of the technique. Finally, provided the potential impact of ambient noise, temperature and respiratory pressure changes is recognised, such external factors rarely represent a major problem.

In the second part of the thesis normative nasal airway dimensions in healthy 94 term neonates are established (paper II). Growth and the influence of recent upper airway infection is addressed by re-examination of 39 of the 94 infants one year later (paper III). These studies show that AR is quick and easy to perform in infants. It is well tolerated in awake infants and can easily be performed during sleep, if necessary.

The AR measurements are adequately sensitive for detailed studies of nasal airway growth and to monitor physiological mucosal changes in infancy. The validity of AR is supported by the

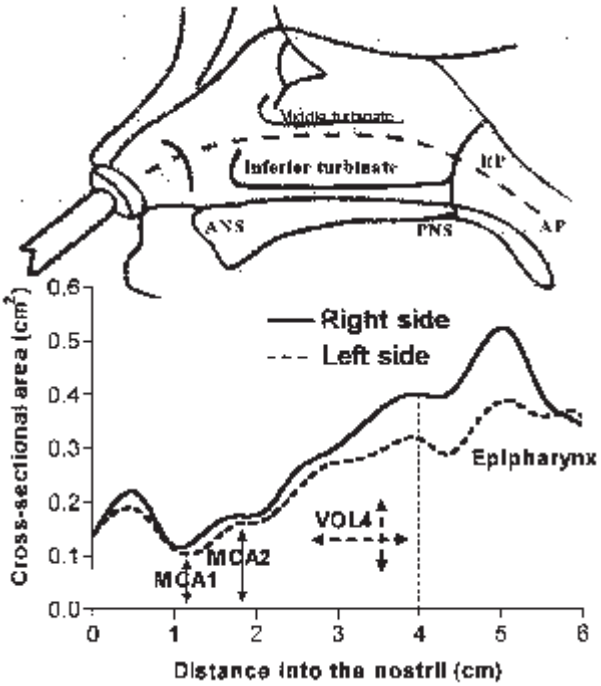

Figure 1: Drawing illustrating the course of the acoustic pathway (AP) position of the inferior turbinate, middle turbinate, anterior and posterior nasal spine (ANS/PNS), epipharynx (EP) and their relationship to the features of an acoustic rhinogram from a one year old infant. (MCA1 is the cross-sectional area corresponding to the internal isthmus, MCA2 corresponds to the head of the inferior turbinate and VOL4 is the volume of the anterior 4 cm..(Printed in Paper III, reprinted with permission).

* Received for publication April 9, 1999; accepted April 23, 1999

close agreement with dimensions obtained from direct in vivo measurements, CT and post-mortem studies reported in the literature.

The fourth study (paper IV) addresses the possible effect of unilateral nasal occlusion on lung function in 17 healthy term neonates. Artificial external unilateral nasal occlusion did not alter lung function parameters significantly, suggesting that the nasal airway dimensions in awake healthy neonates are sufficiently large to maintain normal ventilation, even in cases of complete unilateral occlusion.

In the last study of the thesis (paper V), the application of AR in the clinical setting is evaluated in 6 neonates with congenital or acquired nasal obstructions. Comparison with clinical data and CT-scans show that AR represents a valuable tool for diagnosis and follow-up of congenital choanal malformation and inflammatory nasal obstruction. Models studies confirmed that assessment of dimensions posterior to the nasal septum is not reliable with the current algorithm.

CONCLUSIONS

The results from validations studies in models and, the close correlation with nasal airway dimensions in infants obtained by direct measurements and CT-scans, strongly suggest that the optimised AR equipment represents a reliable diagnostic and investigative tool in paediatric rhinology. The non-invasive nature, simplicity and rapidity of the method are prime assets in infants and small children. AR opens new perspectives and possibilities in the assessment of the nasal airway and its relationship to other common pathological conditions in both the upper and lower airways.

LIST OF PUBLICATIONS INCLUDED IN THE THESIS:

1 Djupesland PG, Lyholm B. Technical abilities and limitations of acoustic rhinometry optimised for infants. Rhinology 1998; 36: 104-13.
2 Djupesland PG, Lyholm B. Nasal airway dimensions in term neonates measured by continuous wide-band noise acoustic rhinometry. Acta Otolaryngol (Stockh) 1997; 117:424-32.
3 Djupesland PG, Lyholm B. Changes in nasal airway dimensions in infancy. Acta Otolaryngol (Stockh) 1998; 118: 852-8.
4 Djupesland PG, Lødrup Carlsen KC. Nasal airway dimensions and lung function in healthy, awake neonates. Pediatr Pulmonol 1998; 25: 99-106.
5 Djupesland PG, Kaastad E, Franzén G. Acoustic rhinometry in the evaluation of congenital choanal malformations. Int J Ped Otorhinolaryngol 1997; 41: 319-337.

Address for correspondence:

Per Gisle Djupesland, MD.
Department of Otorhinolaryngology
Ullevål University Hospital, 0407 Oslo, Norway.
Phone: +47 22 11 85 70. Fax: +47 22 11 85 55.
E-mail: per.djupesland@ioks.uio.no

Request for thesis on CD-rom:
RhinoMetrics a/s, Industrivej 9, DK-3450 Lynge.
E-mail: info@rhinometrics.com