

# Comparison of four methods for assessing airway sealing pressure with the laryngeal mask airway in adult patients

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We have compared four tests for assessing airway sealing pressure with the laryngeal mask airway (LMA) to test the hypothesis that airway sealing pressure and inter-observer reliability differ between tests. We studied 80 paralysed, anaesthetized adult patients. Four different airway sealing pressure tests were performed in random order on each patient by two observers blinded to each other's measurements: test 1 involved detection of an audible noise; test 2 was detection of end-tidal carbon dioxide in the oral cavity; test 3 was observation of the aneroid manometer dial as the pressure increased to note the airway pressure at which the dial reached stability; and test 4 was detection of an audible noise by neck auscultation. Mean airway sealing pressure ranged from 19.5 to 21.3 cm H<sub>2</sub>O and intra-class correlation coefficient was 0.95–0.99. Inter-observer reliability of all tests was classed as excellent. The manometric stability test had a higher mean airway sealing pressure ( $P < 0.0001$ ) and better inter-observer reliability ( $P < 0.0001$ ) compared with the three other tests. We conclude that for clinical purposes all four tests are excellent, but that the manometric stability test may be more appropriate for researchers comparing airway sealing pressures.

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An airway sealing pressure or 'leak' test is commonly performed with the laryngeal mask airway (LMA) to quantify the efficacy of the seal with the airway.<sup>1</sup> This value is important as it indicates the feasibility of positive pressure ventilation and the degree of airway protection from supracuff soiling. It is also used in LMA studies as an index of successful placement.<sup>2</sup> The most common airway sealing pressure test involves listening over the mouth and noting the airway pressure at which gas escapes,<sup>3</sup> but other tests have been described.<sup>4</sup> We hypothesized that the mean airway sealing pressure and inter-observer reliability differ between tests. Therefore, in this study, we have compared four tests for assessing leak pressure with the LMA in adult patients.

## Methods and results

After obtaining approval from the Ethics Committee, we studied 80 unselected, consecutive, supine, anaesthetized adult patients undergoing positive pressure ventilation with the LMA. Patients were excluded if they were less than 18 yr, had respiratory tract pathology, required surgery in

the non-supine or non-lithotomy position, were at risk of aspiration or were considered otherwise unsuitable for LMA use.

A standardized anaesthetic was used. Anaesthesia was induced with propofol 2.5 mg kg<sup>-1</sup> and maintained with 1–2% sevoflurane and 100% oxygen. A size 4 LMA was used for females and a size 5 for males. Neuromuscular block was produced with atracurium 0.5 mg kg<sup>-1</sup>. Four different airway sealing pressure tests were performed in random order on each patient by two observers blinded to each other's measurements: test 1 (audible noise) involved detection of an audible noise by listening over the mouth; test 2 (oral capnography) involved placing a carbon dioxide sampling line 5 cm inside the mouth alongside the LMA tube and noting when carbon dioxide was first seen above baseline on the monitor screen (Datex AS/3, response time <1 s); test 3 (manometric stability) involved observation of an aneroid manometer dial (see below) as the pressure from the breathing system increased, and noting the airway pressure at which the dial reached stability (i.e. the airway pressure at which the leak was in equilibrium with fresh gas flow); and test 4 (auscultation) involved detection of

**Table 1** Mean differences between measurements of the two observers, mean of all measurements and reliability of the four airway sealing pressure tests (mean (95% CI))

	Test differences <sup>A</sup> (cm H <sub>2</sub> O)	Mean of measurements <sup>B</sup> (cm H <sub>2</sub> O)	Mean of all A/B (%)	Intra-class correlation coefficient	Reliability
Audible noise	0.9 (0.7–1.1)	20.0 (19.3–20.8)	4.4 (3.3–5.6)	0.98	Excellent
Oral capnography	1.3 (1.0–1.6)	19.5 (18.7–20.2)	6.6 (4.9–8.6)	0.95	Excellent
Manometric stability	0.4 (0.3–0.6)	21.3 (20.6–22.1)	2.0 (1.3–2.8)	0.99	Excellent
Auscultation	1.2 (0.9–1.4)	19.8 (19.0–20.6)	5.9 (4.3–7.3)	0.97	Excellent

an audible noise using a stethoscope placed just lateral to the thyroid cartilage.

Patients were paralysed during the tests and ventilation was assisted manually between each measurement. The head was positioned on a firm pillow and the LMA tube was fixed below the chin. Intracuff pressure was adjusted to and maintained at 60 cm H<sub>2</sub>O using a digital cuff pressure monitor (Mallinckrodt Medical, Athlone, Ireland). Nitrous oxide was not used during testing and care was taken to avoid displacement of the LMA. The expiratory valve of the circle anaesthesia breathing system was closed and fresh gas flow adjusted to 3 litre min<sup>-1</sup>. Airway sealing pressures were measured to within 0.5 cm H<sub>2</sub>O using a calibrated aneroid manometer attached to the proximal end of the LMA. For tests 1, 2 and 4, the gas leak was detected by observer A who could not see the manometer and the value documented by observer B who wore earplugs (tests 1 and 4), and could not see the monitor screen (test 2). After each measurement, observers A and B reversed roles. For test 3, each observer independently documented the position of equilibrium. Observers were therefore blinded to their own preceding measurements for tests 1, 2 and 4 and, in addition, were blinded to each other's measurements for all four tests.

Sample size was calculated after a pilot study of 10 patients and was based on a difference of 10% between two tests with respect to mean airway sealing pressure, a type I error of 0.05 and a power of 0.8. The results were analysed using the Student's *t* test and the intra-class correlation coefficient (ICC).<sup>5</sup> Scores for statistical measurements with the ICC range from 0 to 1 where the former shows no reliability and the latter perfect reliability. A score  $\geq 0.75$  is considered excellent.<sup>6</sup>

All patients were included in the analysis. Mean age, weight and height were 39 (range 18–75) yr, 72 (42–102) kg and 174 (154–195) cm, respectively. The male:female ratio was 46:34. The mean of the differences between measurements of the two observers, mean of all measurements and overall ICC reliability estimates for the four different tests are shown in Table 1. There was no difference between the mean of the measurements of the two observers for all tests. The manometric stability test (test 3) had a higher mean airway sealing pressure ( $P < 0.0001$ ) and better inter-observer reliability ( $P < 0.0001$ ) compared with the

three other tests. The means of the differences for all tests were small relative to the actual mean of all measurements ( $< 7\%$ ).

## Comment

Our data suggest that all four airway sealing pressure tests provided clinically similar measurements and excellent inter-observer reliability. The manometric stability test, however, provided a higher mean value and better inter-observer reliability. This is because the value depends on the escaping gases reaching equilibrium with fresh gas flow, whereas the other tests measure the point of initial gas leak. The precise value measured using the manometric stability test also depends on gas flow as higher flows require a larger gas leak to achieve equilibrium. Lower gas flows should provide mean values closer to the point of initial gas leak. Greater inter-observer reliability of the manometric stability test probably reflects greater intrinsic test variability as only observation of the manometer is required and the dial is static during measurement. We did not test intrinsic test variability because of the difficulties with blinding and the excessive time that would have been required to make the observations. However, the finding of excellent inter-observer reliability strongly suggests that all tests have low intrinsic variability.

In summary, we conclude that for clinical purposes, all four airway sealing pressure tests are excellent, but that the manometric stability test may be more appropriate for researchers comparing airway sealing pressures.

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