The Effect of Leaving Dentures in Place on Bag-Mask Ventilation at Induction of General Anesthesia

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BACKGROUND: The optimum timing for denture removal in edentulous patients before anesthesia and surgery is uncertain.

METHODS: We conducted a prospective, randomized, controlled trial to evaluate the effect of leaving dentures in during bag-mask ventilation at induction of general anesthesia. One hundred sixty-six edentulous patients were randomized to two groups. The Dentures-In group was bag-mask ventilated after induction of anesthesia with dentures left in place. The Dentures-Out group patients had their dentures removed before bag-mask ventilation. The degree of difficulty of bag-mask ventilation was assessed by the anesthesiologist.

RESULTS: Successful bag-mask ventilation, as defined by a increase in $ETco_2$ to 20 mm Hg and back to baseline with 3 L/min fresh gas flow and the adjustable pressure limiting valve at 20 cm H_2O, was achieved in 61 of 84 (73%) of the Dentures-In patients compared with 40 of 81 (49%) of the Dentures-Out patients (odds ratio 0.37, 95% CI = 0.19–0.70, $P = 0.002$).

CONCLUSION: We conclude that bag-mask ventilation is easier in edentulate patients when their dentures are left *in situ* during induction of general anesthesia.

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With an aging population and an estimated prevalence of edentulism among individuals aged >65 yr of 60% (1), patients with dentures are an increasing proportion of patients presenting for general anesthesia.

Dentures are routinely removed before surgery. This is a longstanding practice, justified by concerns about dentures possibly obstructing the airway (2), being damaged, or compromising sterility of the operating room environment. The timing of perioperative removal of dentures varies among institutions. In some hospitals, they are removed preoperatively and left in the patient's room, whereas in others, patients are allowed to wear them to the operating room and have them removed after induction of anesthesia. This prevents embarrassment for patients who prefer not to be seen without their dentures (3). It is often an unspoken axiom among anesthesiologists that it is more difficult to perform bag-mask ventilation in edentulate patients than in patients with intact dentition. However, there are not studies, to our knowledge, evaluating this. Accordingly, we tested the hypothesis that retaining dentures *in situ* in edentulate patients results in easier bag-mask ventilation compared with edentulate patients who have had their dentures removed.

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METHODS

After Hospital Ethics Committee's approval and written informed consent, all adult patients with dentures scheduled to undergo IV induction of general anesthesia were eligible to take part in the trial. Patients requiring a rapid sequence induction were excluded. Patients were randomly allocated using computer-generated random numbers and sequential sealed opaque envelopes to the Dentures-In or Dentures-Out group.

Before induction of anesthesia, the total fresh gas flow on the anesthetic machine was set at 3 L/min and the adjustable pressure limiting (APL) valve at 20 cm H_2O. A standard circle circuit and 2 L bag were used. After induction of anesthesia, at the point of loss of verbal contact, the randomization envelope was opened by the anesthetic technician and the group to which the patient had been allocated was revealed. The Dentures-Out patients had their dentures removed at this point. The Dentures-In patients had their dentures left in place. Bag-mask ventilation was then attempted. The end point for successful bag-mask ventilation was defined as an $ETco_2$ trace increasing to 20 mm Hg and back to baseline. If this was achieved at total fresh gas flow of 3 L/min and APL valve at 20 cm H_2O, bag-mask ventilation was considered to be easy. If it was not achieved, a predetermined protocol was followed to ensure adequate bag-mask ventilation (Fig. 1).

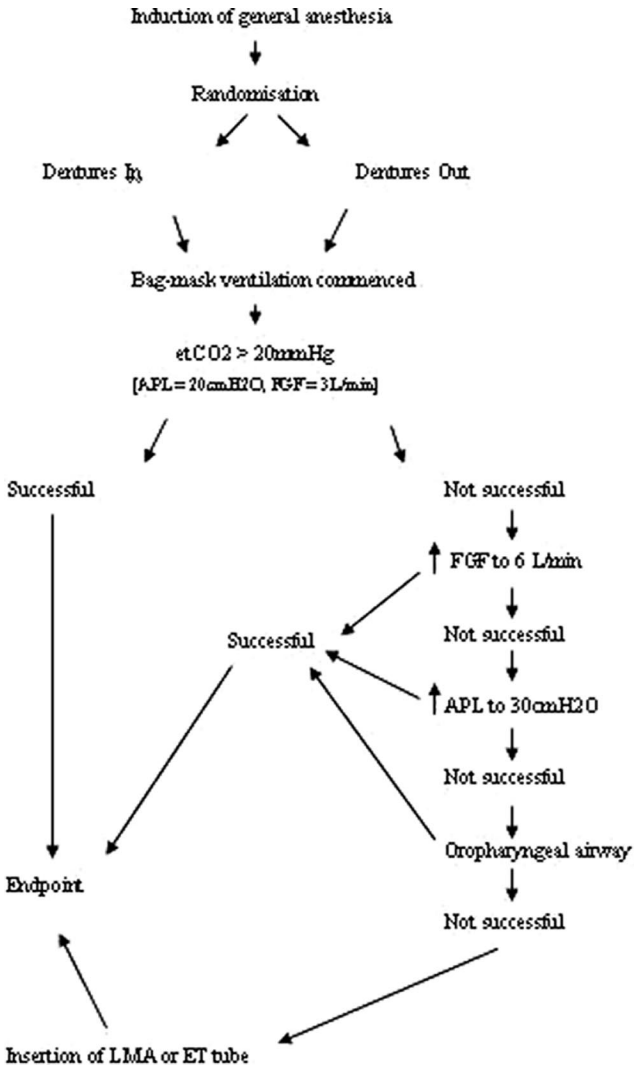

Figure 1. Randomization flowsheet. APL = adjustable pressure limiting valve; FGF = fresh gas flow; LMA = laryngeal mask airway; ET = endotracheal.

This protocol involved first increasing the fresh gas flow to 6 L/min, then closing the APL valve to 30 cm H_2O, using the oxygen flush device, inserting an oropharyngeal airway, using a two-person technique (anesthesiologist uses two hands to secure the mask while an assistant squeezes the bag) or a combination of any of these.

The primary outcome was success of bag-mask ventilation, as previously defined. After a pilot study of $n = 20$ patients, it was calculated that a sample size of 82 patients per group would have 80% power at the 5% significance level to detect a 20% difference in the ease of ventilation. Secondary outcomes included increase in fresh gas flow to 6 L/min, closure of the APL valve to 30 cm H_2O, use of the oxygen flush valve, insertion of an oropharyngeal airway, and use of a two-person bag-mask ventilation technique.

Comparisons were made using χ^2 tests for all primary and secondary outcomes with logistic regression to adjust for the potential confounders: age, sex, body mass index (BMI), facial anatomical abnormalities, presence of a beard, denture type (upper, lower, or both), neuromuscular blockade and anesthesiologist's experience. An intention-to-treat approach was adopted for all analyses.

Table 1. Characteristics of Patients with Dentures Undergoing General Anesthesia

	Dentures-In group ($n = 84$)	Dentures-Out group ($n = 81$)
Age (yr)	70 ± 10	68 ± 13
Gender		
Male	34 (40)	31 (38)
Female	50 (60)	51 (62)
BMI (kg/m^2)	27.4 ± 6.2	27.8 ± 5.2
Denture type		
Full	68 (81)	62 (76)
Upper	16 (19)	19 (23)
Lower	0	1 (1)
Beard	5 (6)	1 (1)
Facial anomaly	5 (6)	2 (2)
Level of experience		
Consultant	38 (45)	26 (32)
Registrar year 3–5	38 (45)	42 (52)
Registrar year 1–2	8 (10)	14 (17)
Neuromuscular blockade		
Yes	44 (52)	37 (46)
No	40 (48)	44 (54)
Induction agents		
Propofol	84 (100)	81 (100)
Dose (mg/kg)	1.60 ± 0.40	1.58 ± 0.39
Fentanyl	74 (88)	72 (89)
Dose (μg/kg)	0.94 ± 0.44	0.94 ± 0.45
Midazolam	38 (45)	42 (52)
Dose (mg/kg)	4.38 ± 5.15	4.47 ± 4.86

Values are mean ± SD; values inside parentheses indicate percentages.
BMI = body mass index.

RESULTS

One hundred seventy-eight patients were approached, which led to the recruitment of 166 patients to the study between June and October 2005 with 84 in the Dentures-In group and 81 in the Dentures-Out group. Of the other 12 patients, eight were unable to give informed consent and four had their operation deferred. One patient was excluded from the Dentures-Out group because of an incomplete data form.

Both groups were comparable with regard to age, sex, BMI, and denture type. Anesthetic induction drugs and the use of neuromuscular blockade were also comparable between groups (Table 1).

Our results showed that adequate bag-mask ventilation occurred in 61 of 84 (73%) of the Dentures-In patients compared with 40 of 81(49%) of the Dentures-Out patients, (odds ratio 0.37, 95% CI = 0.19–0.70, $P = 0.002$). There was also a significant difference in secondary outcomes between the two groups (Table 2).

Adjustment for potential confounders did change the odds ratio for some of the variables. After adjustment for patients with a beard, the odds ratio for ease of bag-mask ventilation changed to 0.32 (95% CI = 0.16–0.63, $P = 0.001$). After adjustment for patients

Table 2. Primary and Secondary Outcomes

	Dentures-In	Dentures-Out	Odds ratio (95% CI)	*P*
Successful[a] bag-mask ventilation	61 (73)	40 (49)	0.37 (0.19–0.70)	0.002
Increased fresh gas flow to 6 L/min	9 (11)	25 (31)	0.27 (0.12–0.62)	0.002
Closure of APL valve to 30 cm H_2O	2 (2)	13 (16)	0.27 (0.12–0.62)	0.002
Oxygen flush valve used	2 (2)	13 (16)	0.13 (0.03–0.59)	0.008
Oropharyngeal airway used	13 (15)	31 (38)	0.30 (0.14–0.62)	0.001
Two-person technique employed	3 (4)	13 (16)	0.19 (0.05–0.71)	0.013

Values are number of patients (%).

The percentages in this table exceed 100%, as in many patients in whom bag-mask ventilation was not successful initially, more than one additional measure was employed eg. increasing the FGF to 6 L/min and closing the APL valve to 30 cm H_2O.

[a] Successful bag-mask ventilation was defined in the study as an end-tidal CO_2 ($ETco_2$) trace increasing to 20 mm Hg and returning to baseline at a total fresh gas flow (FGF) of 3 L/min and adjustable pressure limiting (APL) valve at 20 cm H_2O.

who were given neuromuscular blocking drugs, the odds ratio for ease of bag-mask ventilation changed to 0.31 (95% CI = 0.16–0.63, $P = 0.001$), and adjustment for advanced age in combination with an increased BMI changed the odds ratio to 0.33 (95% CI = 0.16–0.65, $P = 0.001$). Increasing BMI independent of advancing age did not significantly affect the ease of manual ventilation. Adjustment for level of anesthetic experience made little difference to the odds ratio (it changed from 0.37–0.39, CI = 0.20–0.76, $P = 0.005$).

Adjustment for these factors simultaneously made bag-mask ventilation even easier in the Dentures-In group (adjusted odds ratio = 0.23, 95% CI = 0.10–0.52, $P \leq 0.0005$).

DISCUSSION

Provision of adequate bag-mask ventilation remains an important anesthetic skill. To the best of our knowledge, this is the first study to compare the effects of leaving in with removing dentures on ease of bag-mask ventilation. Our results indicate that bag-mask ventilation is significantly easier with dentures left in place.

For effective bag-mask ventilation, both a satisfactory seal of the mask around the patient's mouth and a patent airway are required. Our study results can be explained by considering both of these factors. First, the presence of dentures helps maintain the shape of the facial soft tissues, and thus improves the mask seal around the patient's mouth. In addition, because of a reduction in muscle tone under general anesthesia, the air space in the oropharynx is reduced, and posterior displacement of the tongue, soft palate and epiglottis tend to close the airway (4,5). Because of resorption of alveolar bone and elevation of the tongue in the oral cavity, edentulous patients often have relative tongue enlargement (6). The tongue has been shown to spread laterally when dentures are removed (7), further compromising the patency of the anesthetized airway.

Successful bag-mask ventilation was defined in our study as an increase in end-tidal CO_2 to 20 mm Hg and back to baseline. This was chosen as a simple objective clinical measure.

Although our stated protocol was an attempt to standardize airway management for the purpose of the study, experienced anesthesiologists may choose slightly different management plans, or in different sequence or in combination, as did some who participated in our study. Nonetheless, secondary outcomes are relevant, meaningful clinical indicators of airway difficulty which experienced practitioners can appreciate.

Several complications have been reported secondary to leaving Dentures in place during general anesthesia. Damage to the laryngeal mask airway from the dental prosthesis (8), damage to dentures during laryngoscopy and swallowing of dentures in the post-anesthetic recovery room (9), as well as cases of airway obstruction have been reported in the literature. The incidence of airway obstruction from leaving dentures in place is unclear. The Australian Incident Monitoring Study involves the voluntary anonymous reporting in Australia and New Zealand of any unintended incident during anesthesia which reduced or could have reduced the safety margin for a patient. In the first 4000 Australian Incident Monitoring Study reports, there were 62 cases of airway obstruction in which laryngospasm was thought not to be the cause. In seven cases a foreign body was the cause, and in one of these the foreign body was a denture (10). In our study, all dentures in both groups were removed after bag-mask ventilation but before insertion of the laryngeal mask airway or endotracheal tube. No complications from leaving dentures in place during bag-mask ventilation were reported.

Our study had some limitations. It was not possible to blind the anesthesiologist to patient group assignment. In an attempt to limit selection bias, the randomization envelope was opened by the anesthetic technician after induction of anesthesia just before commencement of bag-mask ventilation.

We did not record the age at which patients became edentulous. This may be relevant, as patients who become edentulous earlier in life are more likely to have more residual alveolar bone, and thus better-fitting dentures. Patients who become edentulous later in life tend to have less residual alveolar bone and thus poorer-fitting dentures which, in turn, are less useful for maintaining an airway during bag-mask ventilation. Both groups however were comparable

for age, and thus were likely to be comparable for length of edentulous time.

We did not record whether patients used denture adhesive or not. It could be argued that dentures that require dental adhesive to remain *in situ* may be more likely to have them dislodge with trivial soft tissue maneuvers and may enhance airway obstruction.

In our study, general anesthesia was induced in all patients with their dentures left in place. In patients who ordinarily used dental adhesive, adhesive was used as normal. In patients who did not wear adhesive ordinarily, no adhesive was used. We felt that patients who were wearing their dentures with adhesive were no more likely to have them dislodge and cause problems than patients with dentures which were better fitting and did not require adhesive.

In conclusion, we found bag-mask ventilation after induction of general anesthesia to be significantly easier when dentures were left in. For this reason, we recommend that all patients with dentures should routinely come to the operating room with their dentures left in place and have them removed once the airway is secured.

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REFERENCES

1. Dixon GS, Thomson WM, Kruger E. The West Coast Study SI: self-reported dental health and the use of dental services on the West Coast of the South Island of New Zealand. N Z Dent J 1997;93:39–43
2. Dibiase AT, Samuels RH, Ozdiler E, Akcam MO, Turkkahraman H. Hazards of orthodontics appliances and the oropharynx. J Orthod 2000;27:295–302
3. Cobley M, Dunne JA, Sanders LD. Stressful pre-operative procedures. Anaesthesia 1991;46:1019–22
4. Boidin MP. Airway patency in the unconscious patient. Br J Anaesth 1985;57:306–10
5. Nandi PR, Charlesworth CH, Taylor SJ, Nunn JF, Dore CJ. Effect of general anaesthesia on the pharynx. Br J Anaesth 1991; 66:157–62
6. Vogel JE, Mulliken JB, Kaban LB. Macroglossia: a review of the condition and a new classification. Plast Reconstr Surg 1986;78:715–23
7. Cohen AM, Vig PS. Lateral tongue spreading. J Dent 1973; 2:32–4
8. Shah T, Jones N. Well-fitting dentures: friend or foe? Anaesthesia 2004;59:921–2
9. Twou YW, Hwang SJ, Yu FK, Liou CS, Chang YT, Ho ST. Swallowing of fixed denture following general anesthesia—a case report. Acta Anaesthesiol Sin 1995;33:133–6
10. Visvanathan T, Kluger MT, Webb RK, Westhorpe RN. Crisis management during anaesthesia: obstruction of the natural airway. Qual Saf Health Care 2005;14:E1