Airtraq® versus Macintosh laryngoscope for airway management during general anesthesia: A systematic review and meta-analysis of randomized controlled trials

SUPPLEMENTARY DIGITAL CONTENT

Content:

Supplementary Table 1. Inclusion and exclusion criteria of included studies.

Study	Inclusion criteria	Exclusion criteria	Outcome(s)	Findings
Abdallah et al. 2019	18–60 years old, with the American Society of Anesthesiologists physical status class I or II, having no criteria for suspected difficult intubation, scheduled for various types of nonophthalmic elective surgery requiring orotracheal intubation.	Patients with raised IOP or intracranial pressure, suspicion of difficult intubation, need for rapid sequence induction, gastric acid aspiration risk, suspicion or history of difficult intubation, cervical spine pathology, body mass index ≥35, cardiovascular, hyperreactive airway disease, and/or on β-blocker therapy	intubation time, first-attempt success rate, time to best laryngoscopic view, and percentage of glottic opening (POGO) score	In comparison to the Macintosh laryngoscope, Airtraq conferred significantly better intubation criteria and lesser stress response to laryngoscopy and intubation.
Al-Ghamdi et al. 2016	Patients aged 18 to 65 years, with an ASA physical status classification of I to II, who were scheduled for elective surgery and whose anesthesia plan included routine orotracheal intubation	Patients with an anticipated or known difficult intubation such as history of cervical spine injury or surgery; limited neck mobility; previous oral or throat surgery or difficult direct laryngoscopy; a Body Mass index >35 kg/ m2; or missing incisor teeth	Time to tracheal intubation. Secondary outcomes included the laryngoscopic view, numbers of laryngoscopy attempts, first-pass success rate, optimization maneuvers, ease of intubation, and postoperative sore throat.	The Airtraq® require longer intubation times, as primary outcome, and cause less sore throat than the Macintosh when used by anesthesiologists with limited experience in patients with normal airways.
Bhandari et al. 2013	ASA physical status I and II, age group 16-65 years of either sex, patients with head injury, psychiatric disorder, respiratory tract (oropharynx, larynx) pathology, endocrine disorder, predicted difficult airway (such as mouth opening <2 cm, modified MPS class 3 and 4, BMI > 35 kg/m^2.	Gastroesophageal reflux disease, hiatus hernia, and pregnancy.	Overall success rate of tracheal intubation, overall duration of successful tracheal intubation, optimization maneuvers, POGO score and ease of intubation.	Both Airtraq and Macintosh laryngoscopes are equally effective in tracheal intubation in normal airways. Duration of successful tracheal intubation was shorter in the Airtraq group which was statistically significant.
Chalkeidis et al. 2010	ASA status I–III	(1) patients requesting regional anesthesia; (2) the need for endotracheal tubes that are armored, cranial-facing or caudal-facing, or the need for a nasotracheal tube, as indicated by the type of surgery; (3) history of an impossible or difficult intubation; (4) emergency surgery.	The time needed for intubation, any assistance required, complications during and after laryngoscopy and intubation, and the number of unsuccessful intubation attempts.	The Airtraq laryngoscope is easier to use but it does not have any significant advantages compared with the Macintosh laryngoscope for routine airway management.

Çolak et al. 2015	ASA status of I to III, and who were aged between 20 and 75	a history of emergency intubation or difficult intubation, a body mass index higher than 35 or a rheumatologic disease that causes limitation of cervical motion, a previous history of cervical operation or tumor, trauma or infection on upper airway, and the absence of teeth. Anthropometric measurements such as tiromental (thyroidea and gnathion) and sternomental (sternal and gnathion) distances, inter-incisor gap (between the lower and upper incisor teeth), neck circumference (at the level of the thyroid cartilage), and lower face height (between gnathion and subnasale) were measured and recorded by an anatomist the night before the operation.	The extension angle during intubation and the Cormack-Lehane Score	A minimal cervical motion was obtained during tracheal intubation with the use of Airtraq® laryngoscope compared with the Macintosh laryngoscope.
Ertürk et al. 2015	ASA I-II, 18-65 years old	Pregnant women; patients with gastrooesophageal reflux, delayed gastric emptying; severe respiratory and cardiovascular problems; those who had intraoral, neck, pre-planned emergency, neck dissection, larynx and thyroid surgeries; those who had failed intubation despite three successful at-tempts and those who refused to be a part of this study	Patients' snoring complaints, modified Mallampati scores, sternomental distances, thyromental distances, interincisor distance measurements and Cormack-Lehane (C-L) laryngoscopic classification, upper lip bite test results, intubation time, number of intubation attempts, maneuvers and techniques used for facilitating intubation and complications arising from intubation	In cases with seemingly difficult intubations, we believe the Airtraq laryngoscope has an advantage over the Macintosh laryngoscope, owing to its better view of the oropharyngeal and glottic areas in addition to facilitating intubation in patients with limited head extension.
Ferrando et al. 2011	Patients scheduled for any kind of surgery who required tracheal intubation	Patients who could require rapid sequence induction, ASA physical status 4, age under 18 yr, and an interincisor distance less than 3 cm	The Cormack-Lehane score, the success rate at first intubation attempt, and the laryngoscopy and intubation times.	The Airtraq is a useful laryngoscope in unskillful anesthesiology residents improving the laryngeal view

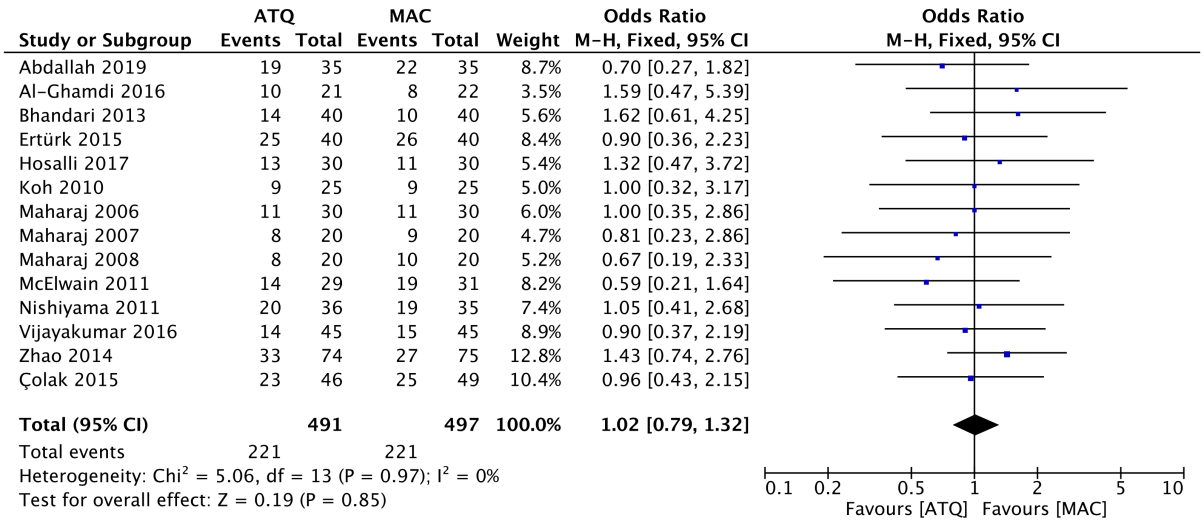
				and, therefore, facilitating the tracheal intubation.
Hindman et al. 2014	(1) Mallampati airway class I or II, (2) thyromental distance of 6.0 cm or greater, and (3) sterno-mental distance of 12.5 cm or greater.; (4) age 18 to 80 yr, (6) height between 1.52 and 1.83 m, and (6) body mass index of 30.0 kg/m^2 or less.	(1) maxillary incisors that were loose or poor condition, (2) previous difficult intubation, (3) any cervical spine anatomic abnormalities such as disc disease, instability, myelopathy, and/or any previous cervical spine surgery, (4) symptomatic gastroesophageal reflux or reactive airway disease, (5) any his- tory of coronary artery disease or cerebral aneurysm, regard- less of symptom status, (6) any history of vocal cord and/or glottic disease or dysfunction, (7) preoperative systolic blood pressure greater than 180 mmHg or diastolic blood pressure greater than 80 mmHg, and (8) ASA physical status class greater than 3.	(1) maximal laryngoscope force application, and (2) maximal overall (Oc-C5) cervical spine motion (extension).	Cervical spine motion is affected by the amount of force applied by the laryngoscope but shows that intubation biomechanics are nonlinear and differ markedly between laryngoscopes. Although intubation with the Airtraq required only 20% of the force required by the Macintosh (~10 vs. ~50 N), it resulted in 67% as much Oc-C5 motion (~20 vs. ~30 degrees).
Hosalli et al. 2017	ASA physical status I–II patients, aged 18–60 years, scheduled for various elective surgeries under general anaesthesia requiring tracheal intubation.	Patients with risk factors for difficult intubation (modified Mallampati class III and IV, thyromental distance <6 cm, interincisor distance <3 cm, body mass index more than 30 kg/m^2), risk for gastric aspiration, relevant drug allergy.	(1) The difficulty of tracheal intubation based on intubation difficulty scale (IDS) score; (2) glottic view according to Cormack-Lehane grading; (3) number of optimization techniques (use of bougie, different size blade, stylet) (4) impact on haemodynamic variables such as heart rate (5) mean arterial blood pressure; (6) and oxygen saturation, which were recorded preintubation, 1, 3 and 5 min after intubation	In patients undergoing endotracheal intubation with cervical immobilisation, Airtraq™ laryngoscope was superior to the Macintosh laryngoscope, with greater ease of intubation and lower impact on haemodynamic variables.
Koh et al. 2010	Patients aged 20 to 60 years, with ASA physical status I-II who were scheduled	The risk factors for increased dental injury, pulmonary aspiration, functional or anatomical deformities in the airway	Intubation time, success rate of first intubation attempt, number of intubation attempts,	The Airtraq offers a better laryngeal view and higher success rate at first intubation

	to undergo surgical procedures necessitating tracheal intubation.	(i.e., asthma, burn, and tumor), anticipated airway difficulties (i.e., Mallampatti grade IV or having prior history of difficult airway), and body mass index greater than 30. Patients were also excluded if surgery required one lung ventilation or a different endotracheal tube other than the conventional endotracheal tube used.	and percentage of glottic opening (POGO) score.	attempt in patients who are applied with a Philadelphia cervical collar due to suspicion of cervical spine injury.
Maharaj et al. 2006	ASA physical status I–III patients, aged 18 years of age or older, scheduled for surgical procedures requiring tracheal intubation	Risk factors for gastric aspiration and / or risk factors for difficult intubation (Mallampatti class III or IV; thyromental distance less than 6 cm; interincisor distance less than 4.0 cm) were present or where there was a history of relevant drug allergy.	The duration of the tracheal intubation procedure and the intubation difficulty scale (IDS) score. A secondary endpoint was the rate of successful placement of the tracheal tube (ETT) in the trachea.	The Airtraq® laryngoscope offers a new approach for the management of the normal airway. The Airtraq® reduced the difficulty of tracheal intubation and the degree of haemodynamic stimulation compared to the Macintosh laryngoscope in patients at low risk for difficult laryngoscopy and intubation.
Maharaj et al. 2007	ASA physical status I–III, aged 18 yr or older, scheduled to undergo surgical procedures necessitating tracheal intubation.	Risk factors for gastric aspiration and/or difficult intubation (Mallampati class III or IV, thyromental distance less than 6 cm, interincisor distance less than 4.0 cm) were present, or where there was a history of relevant drug allergy.	The duration of the tracheal intubation procedure and the IDS score. A secondary endpoint was the rate of successful placement of the ETT in the trachea.	Authors demonstrate the utility of the Airtraq laryngoscope for tracheal intubation in patients with cervical spine immobilization.
Maharaj et al. 2008	ASA physical status 1–3 patients, aged 18 years of age or older, who were deemed on pre-operative assessment by their primary anesthetist to be at increased risk for difficult tracheal intubation and scheduled for surgical procedures requiring tracheal intubation. Inclusion criteria consisted of possession of at least three of the following criteria:	NS	The duration of the tracheal intubation procedure and the IDS score. A secondary endpoint was the rate of successful placement of the tracheal tube in the trachea.	Tracheal intubation with the Airtraq also reduced the degree of haemodynamic stimulation and minor trauma compared to the Macintosh laryngoscope.

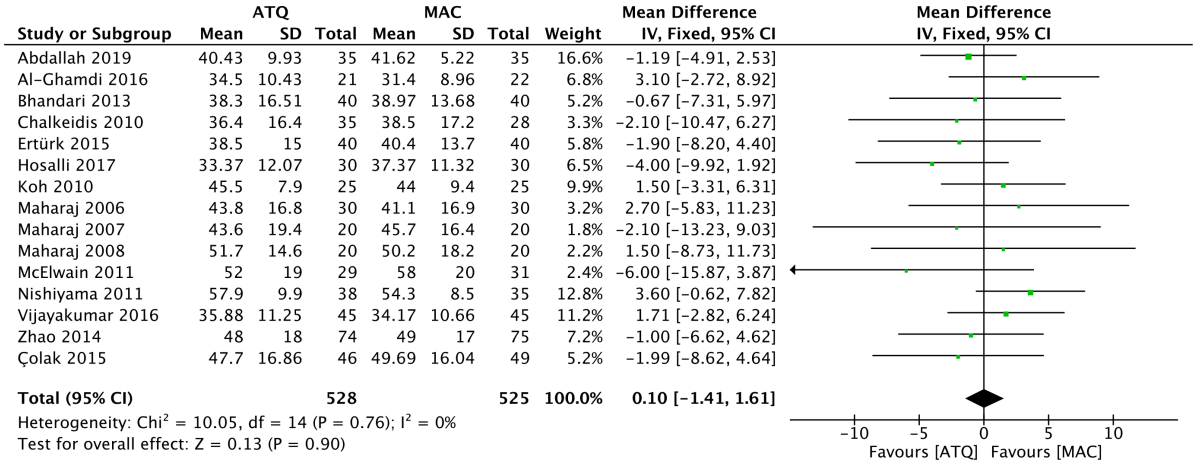
	(1) thyromental distance < 6 cm; (2) Mallampatti classification 3 or 4; (3) interincisor distance < 4 cm; (4) previously documented difficult intubation.			
McElwain et al. 2011	ASA physical status I – III patients, aged 16 yr or older, undergoing surgical procedures requiring tracheal intubation.	Risk factors for gastric aspiration, difficult intubation, or both (Mallampati class III or IV; thyromental distance ,6 cm; inter-incisor distance ,3.5 cm) were present, or where there was a history of relevant drug allergy.	The intubation difficulty scale (IDS) score. Secondary endpoints were the duration of the laryngoscopy attempt, duration of the tracheal intubation procedure, the total time required to secure the airway, and the rate of successful placement of the TT in the trachea.	The Airtraq® laryngoscope performed better than the Macintosh laryngoscopes in patients undergoing cervical immobilization
Nishiyama 2011	ASA physical status I or II scheduled for general anesthesia aged 30 to 70 years.	History of surgery or any other diseases of neck and face.	Number of the attempts), and the time required for successful tracheal intubation.	The MAC and ATQ were better than the AWS-Miller for patients with easy intubation, while the ATQ was better than the MAC for difficult intubation when the expert anesthesiologists did the intubation.
Vijayakumar et al. 2016	Adult patients aged 18 to 60 years of either sex belonging to ASA 1 and 2, with normal airway parameters undergoing elective abdominal, urological, and gynecologic surgeries under general anesthesia requiring endotracheal intubation	Patients at risk for gastric aspiration, anticipated difficult airway (previous history/documented difficult intubation, interincisor distance of <3 cm, bucked tooth, Modified Mallampatti classification III/IV, thyromental distance of <6 cm, restricted neck extension, patient who cannot bring mandibular incisors anterior to maxillary incisors, any gross abnormality of head and neck, and obese with body mass index (BMI) ≥ 30kg/m2).	Successful intubation, and degree of difficulty of intubation as assessed by Intubation Difficulty Scale (IDS) score. Secondary outcomes compared were duration of laryngoscopy and intubation, degree of difficulty of intubation as assessed by Numerical Rating Scale score, soft tissue, and dental trauma.	In anesthetized adult patients with MILS compared with Macintosh, Airtraq provides equal success rate of in-tubation, statistically significant (although clinically insignif-icant) longer duration for laryngoscopy and intubation. Intubation with Airtraq was significantly easier than Macintosh as assessed by the IDS score.

Zhao et al. 2014	ASA hysical status I to II patients, aged between 18 and 65 years old, scheduled for surgical procedures requiring general anaesthesia and tracheal intubation.	A history or any indicator of a difficult airway (i.e. Mallampati grade >2, obesity (body mass index >30 m/kg2), interincisor distance less than 4 cm), or any risk factor of pulmonary aspiration.	Success rate of intubation using each laryngoscope. The number of optimization maneuvers required to perform tracheal intubation. Dental trauma, visible trauma to lip or oral mucosa, and presence of blood on laryngoscope blade were also recorded.	Airtraq laryngoscope is easier to master for novice personnel with a higher intubation success rate and shorter intubation duration compared with the Macintosh laryngoscope.

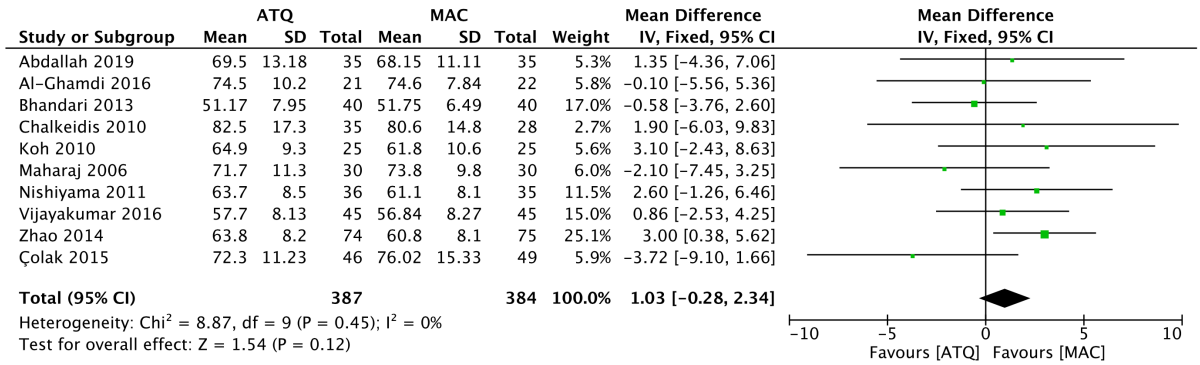
Legend: ASA = American Society of Anesthesiologists; NS = Not specified;



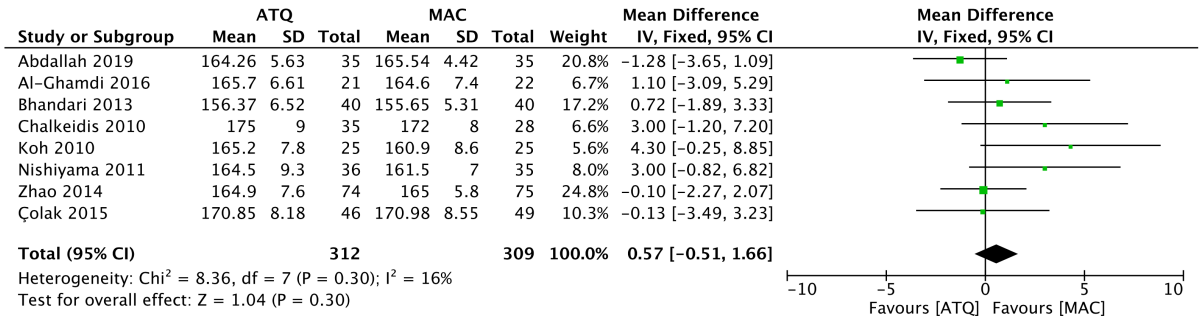
Suppl. Fig. 1. Forest plot of gender of participants (male) in Airtraq vs. Macintosh groups.



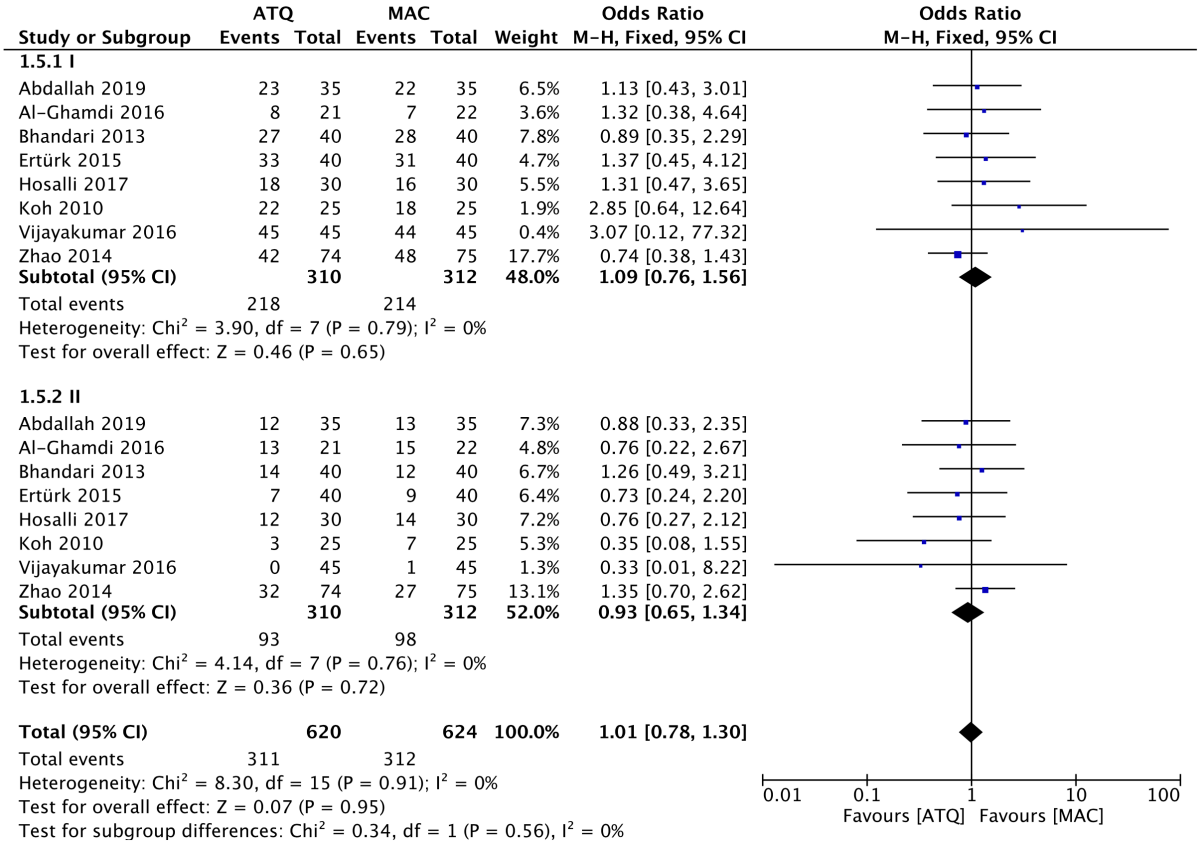
Suppl. Fig. 2. Forest plot of age in Airtraq vs. Macintosh groups.



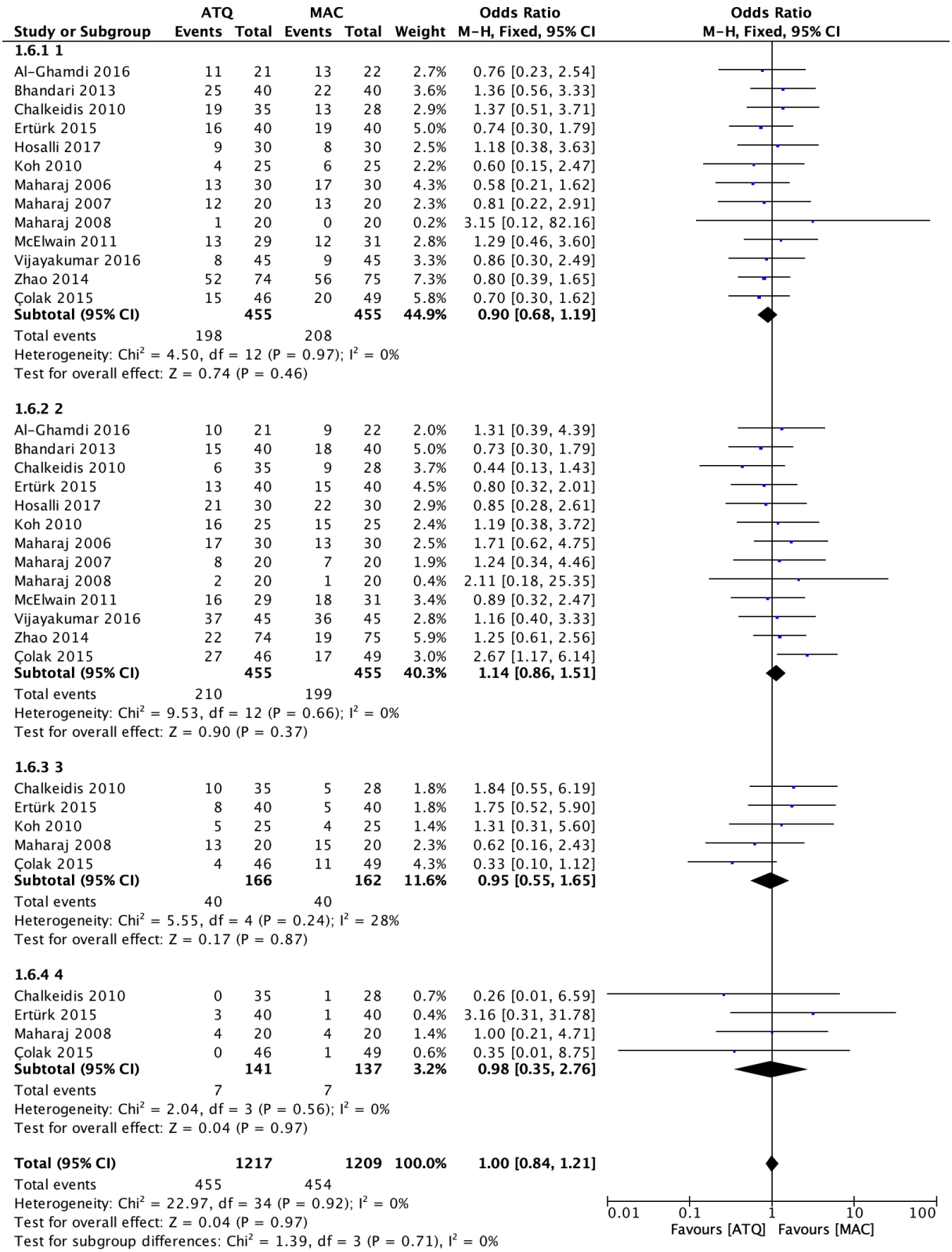
Suppl. Fig. 3. Forest plot of weight [kg] in Airtraq vs. Macintosh groups.



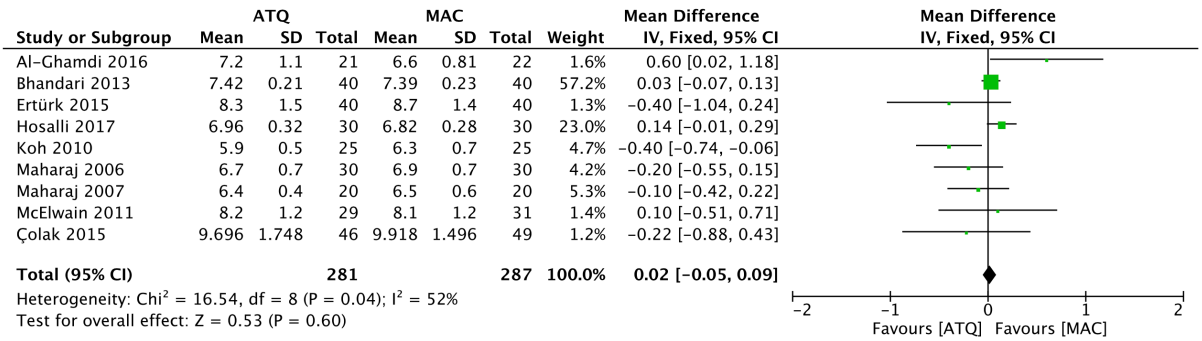
Suppl. Fig. 4. Forest plot of height [cm] in Airtraq vs. Macintosh groups.



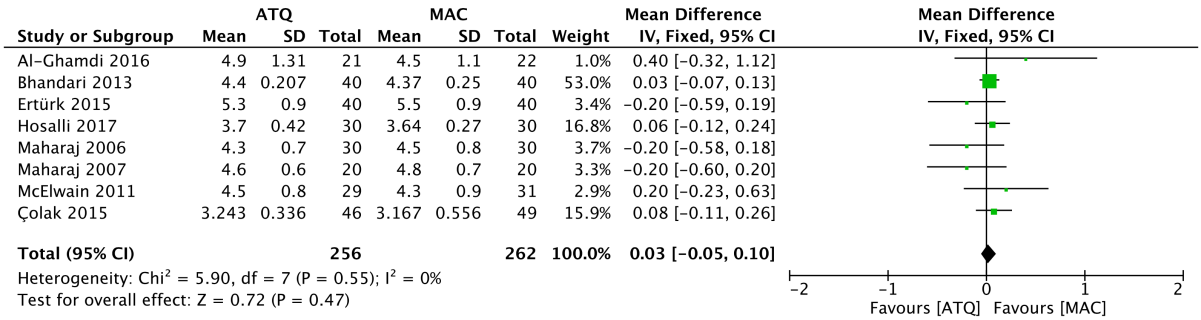
Suppl. Fig. 5. Forest plot of the American Society of Anesthesiologists physical status in Airtraq vs. Macintosh groups.



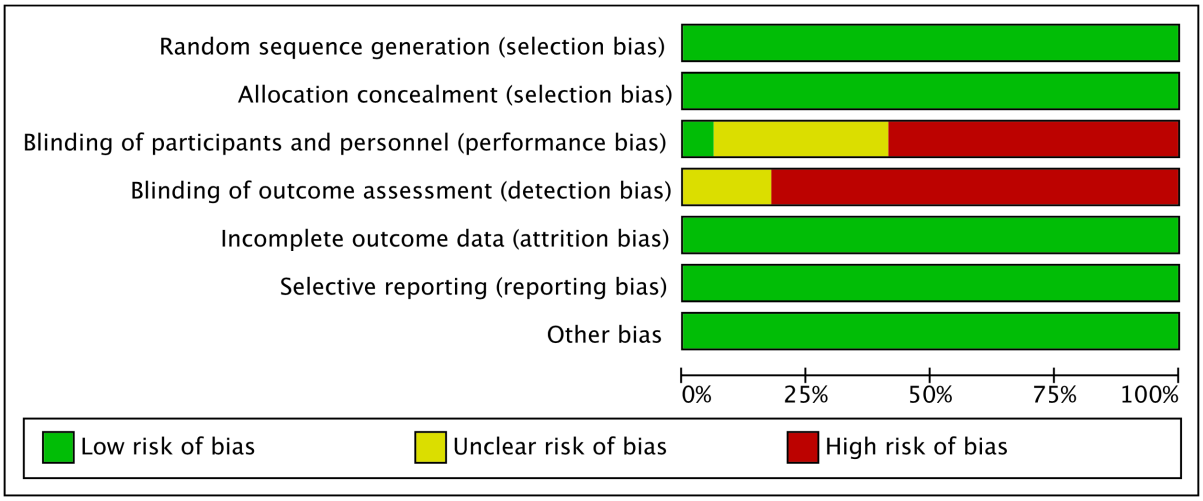
Suppl. Fig. 6. Forest plot of gender of Mallampati classification in Airtraq vs. Macintosh groups.



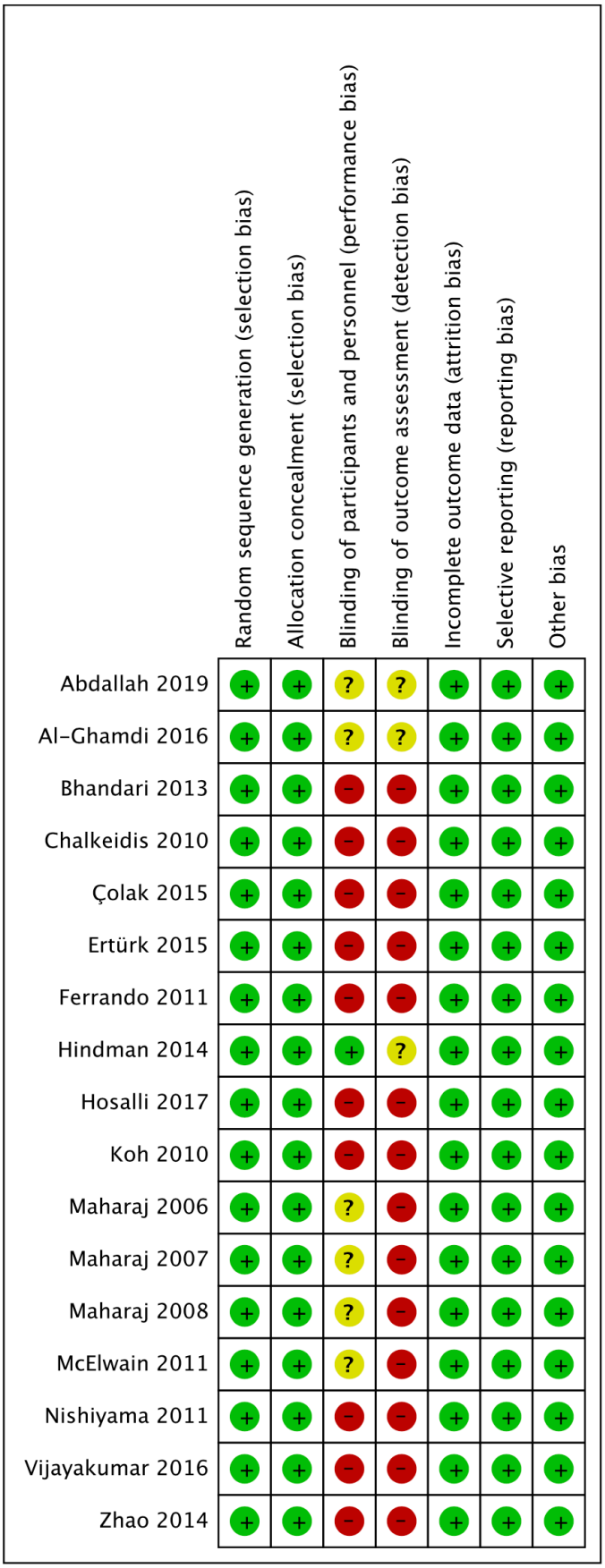
Suppl. Fig. 7. Forest plot of Thyromental distance in Airtraq vs. Macintosh groups.



Suppl. Fig. 8. Forest plot of Inter-incisor distance in Airtraq vs. Macintosh groups.



Suppl. Fig. 9. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Suppl. Fig. 10. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.