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Role of spontaneous and assisted ventilation during general anaesthesia

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Spontaneous ventilation during general anaesthesia has been shown to favour atelectasis formation and decreased functional residual capacity. Therefore, general anaesthesia is commonly associated with endotracheal intubation and mechanical ventilation. Laryngeal lesions, residual curarisation, haemodynamics impairment, but most importantly, situation of cannot ventilate – cannot intubate may occur. Recently developed anaesthetic ventilators are able to detect spontaneous ventilation (triggering) and to give a pressure-limited flow cycled assisted breath (pressure support ventilation, PSV). Spontaneous ventilation assisted by PSV with laryngeal mask may avoid all the complications of endotracheal intubation and mechanical ventilation. Therefore, PSV should be a valid alternative for all patients having general anaesthesia with the exception of some contraindication. A close monitoring of tidal volume and minute ventilation is also needed.
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During more than one century since its first description in 1846, general anaesthesia has been performed with patients breathing spontaneously. However, already in 1858, John Snow reported the pronounced changes that occur in respiration during the inhalation of chloroform.[1] Since then, much effort has been made for the understanding of the effect of general anaesthesia on the respiratory system. Common finding is a decreased tidal volume (Vt) caused by an increased airway resistance and decreased compliance (CL).[2] Moreover, there is a decreased response to hypercapnia leading to decreased Vt and minute ventilation. This shallow breathing will promote atelectasis and cause a decrease in the functional residual capacity (FRC). This phenomenon associated with the decrease in the overall ventilation/perfusion (VA/Q) ratio may cause hypoxaemia over time.[3,4] Moreover, as

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respiratory response to hypoxaemia is also decreased, there will be no increase in spontaneous ventilation.

Therefore, rapidly after the discovery of the myorelaxant associated with endotracheal intubation and mechanic ventilation, spontaneous ventilation through a facemask became less popular. Instead, the common practice for general anaesthesia since 1960 has been tracheal intubation (TI) with intermittent positive pressure ventilation (IPPV). Facemask anaesthesia with spontaneous ventilation has been reserved for simple and short procedures.

Today, in most of the European countries, general anaesthesia is still performed with IPPV and TI. In some countries, spontaneous ventilation has regained favour since the development of the laryngeal mask (LM).

However, after nearly 50 years of research on the effect of general anaesthesia on respiratory system and more than 20 years of clinical use and improvement of LM, is there any evidence to prefer spontaneous versus controlled mechanical ventilation in selected patients?

Why avoid tracheal intubation and mechanical ventilation?

Laryngo-tracheal lesions have been described after endotracheal intubation with an incidence of 6%. Fortunately, these complications are most often without sequel.[5] Difficult intubations are associated with an increased risk of 8–10% with more often long-term sequel.[6] The lesions consist of vocal cord oedema or haematoma, vocal cord laceration and lesion to the arytenoids.[7] For long-term intubation (more than 24 h), nearly 90% of the patients present some laryngeal lesions when systematic laryngoscopy is performed after extubation. In these situations, long-term sequel arises in 8% of all patients.[8]

Good muscular relaxation is needed for endotracheal intubation. This is most often obtained by injection of a myorelaxant. Unfortunately, curarisation is associated with number of side effects. First of all, every time this drug is injected, anaesthesiologists have to secure the airways and perform mechanical ventilation. It has been largely described that this may lead, rarely, to a situation of cannot intubate–cannot ventilate with sometimes leading to death of the patients.[9] Another potential complication is anaphylactic reaction. However, today, the most important complication of the use of myorelaxant is probably residual curarisation, which has been described to occur in 10–50% of all patients in the recovery room.[10] Residual curarisation, even for a short period of time, increases the risk of postoperative complication threefold.[11] For all these reasons, it may be advisable to avoid myorelaxation, whenever possible.

Some anaesthesiologists have recommended techniques of induction for TI without the use of myorelaxant. This cannot be recommended due to the increased risk of difficult intubation and laryngeal lesion.

There are numerous studies indicating that incidence of difficult intubation is increased when neuromuscular blocking agents (NMBAs) are avoided. Recently, a Danish study showed that the risk is increased by a factor of 1.5 when NMBAs are avoided in a population of over 100 000 patients.[12] Other studies have shown that incidence of laryngeal injuries is increased in case of difficult intubation and/or when NMBAs are not used.[7,13] Therefore, TI without the use of NMBAs is not recommended for daily practice and is not an alternative to avoid postoperative residual curarisation.

For safety reasons, it is a common practice to give patients 100% oxygen for few minutes before extubation to increase the oxygen stores. This manoeuvre will favour atelectasis formation.[14] In patients at particular risk, such as morbidly obese patients or after thoracic surgery, atelectasis may increase the risk of postoperative pulmonary complication.[15–17] In addition, it is very difficult to recruit the lung after extubation.

Last but not least, positive pressure ventilation (PPV) has some cardiovascular effects due to heart–lung interaction. There is a decrease in venous return, a negative effect on right ventricle by a decrease in preload and increase in afterload and an alteration in left ventricle compliance. All these effects will decrease cardiac output and systemic arterial pressure.[18]

All these potential harmful effects of endotracheal intubation associated with IPPV may be lessened by the use of assisted ventilation.

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