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Magnetic resonance imaging study of the *in vivo* position of the extraglottic airway devices i-gel™ and LMA-Supreme™ in anaesthetized human volunteers

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Editor's key points

- The anatomical *in situ* position of two extraglottic airway devices was investigated using magnetic resonance imaging.
- The LMA-S protrudes deeper into the upper oesophageal sphincter (UOS) than the i-gel™, despite fibreoptically identical positions.
- The i-gel™ causes a greater dilation of the upper UOS.
- The LMA-S compresses the laryngeal inlet more than the i-gel™.

Background. Exact information on the anatomical *in situ* position of extraglottic airway (EGA) devices is lacking. We used magnetic resonance imaging (MRI) to visualize the positions of the i-gel™ and the LMA-Supreme™ (LMA-S) relative to skeletal and soft-tissue structures.

Methods. Twelve volunteers participated in this randomized, prospective, cross-over study. Native MRI scans were performed before induction of anaesthesia. Anaesthesia was induced, and the two EGAs were inserted in a randomized sequence. Their positions were assessed functionally, optically by fibrescope, and with MRI scans of the head and neck.

Results. The LMA-S protruded deeper into the upper oesophageal sphincter than the i-gel™ ($P<0.001$). Both devices reduced the area of the glottic aperture ($P<0.001$), and the LMA-S had the largest effect ($P=0.049$). The i-gel™ significantly compressed the tongue ($P<0.001$). Both devices displaced the hyoid bone ventrally ($P<0.001$); the i-gel™ to a greater degree ($P=0.029$). The fibreoptically determined position of the bowl of the devices was identical.

Conclusions. The LMA-S and i-gel™ differ significantly with regard to *in situ* position and spatial relationship with adjacent structures assessed by MRI, despite similar clinical and fibreoptical findings. This could be relevant with regard to risk of aspiration, glottic narrowing, and airway resistance and soft-tissue morbidity.

Keywords: i-gel™; laryngeal mask airway; LMA-Supreme™; magnetic resonance imaging

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Extraglottic airway (EGA) devices are suitable for ventilation of the lungs because their cuffs form an airtight seal that isolates the distal airways. This pharyngeal–laryngeal seal, which is quantified by the leak pressure, is crucial for the ventilatory efficiency and for protecting the airways from material surrounding the cuff. For laryngeal mask airway type devices, it results from the close contact between the cuff surrounding a supraglottic bowl at the end of the ventilation tube and the adjacent soft tissues of the pharynx and the tongue.

In addition, the tips of the devices are designed to provide a certain degree of protection against the reflux of gastric contents by occluding the upper oesophageal sphincter (UOS; so-called oesophageal seal) and by venting off regurgitated fluids and gases through a drainage tube.

The original laryngeal mask airway design was based on studies of post-mortem laryngeal specimens[1] as were subsequent studies on the anatomical position.[2] No comparative study had been performed to date to test whether their *in situ* positions in living humans actually corresponded to those extrapolated from the cadaver studies. Previous studies in living patients have been confined to assess the position of the exterior surface of the EGA and the position of its bowl relative to the glottis by fibreoptic observations.

In the present prospective, randomized, cross-over study in anaesthetized volunteers, we used magnetic resonance imaging (MRI) to visualize and compare the *in situ* positions of two popular EGA devices with drainage channels, the LMA-Supreme™ (LMA-S, The Laryngeal Mask Company Ltd, St Helier, Jersey, UK)[3 4] and the i-gel™ (Intersurgical Ltd, Wokingham, UK).[5]

The LMA-S has an inflatable cuff with a strongly tapered tip, while the i-gel™ has a non-inflatable gel-cuff with a blunter and wider tip. The cuff of the LMA-S is longer than that of the i-gel™, and one might conclude that it would protrude further into the

UOS than the i-gel™. However, the distance from the intended position of the epiglottis in relation to the bowl until the tip of the cuff is similar for both devices. Nevertheless, because of its more strongly tapered tip, we hypothesized that the tip of the LMA-S might insert deeper into the UOS, whereas the blunter and wider tip of the i-gel™ might simply cause more soft-tissue displacement at the level of the UOS.

Thus, the aim of the present study was to provide the first comparative images of EGA devices *in situ* in living humans and to test our assumptions regarding the depth of insertion and the effects on the UOS. We also looked for differences regarding soft-tissue effects due to the EGA insertion focusing on the glottis as well as the tongue.

Methods

Participants

This study was approved by our institutional review board (Clinical Trial Number, German Clinical Trial Registry: DRKS00003172). Twelve ASA I volunteers (six male, six female) were recruited and participated in the study after giving their written informed consent. General inclusion criteria were age >18 yr, body weight between 60 and 80 kg, no history of gastric reflux, no known or expected difficult airway, and a history of at least one uneventful general anaesthesia during the 5 yr period before the study. Potential participants were screened for undiagnosed medical conditions with an ECG and blood analysis for haemoglobin, electrolytes, creatinine, international normalized ratio, and activated partial thromboplastin time.

The participants were selected to represent the normal range of body heights in the German population. The normal ranges for males and females (German Institute for Economic Research, 2006) were stratified into three groups (males 170–174, 175–179, and 180–184 cm; females 160–164, 165–169, and 170–174 cm), and two participants were recruited for each of the six groups. We restricted body weight to between 60 and 80 kg, since this is the mid-range for a size 4 i-gel™ with its constant sized cuff. The LMA-S manufacturer recommends a size 4 as the first choice for all normal adults, since the sizes 4 and 5 differ only in the length of the airway tube but not in the size or shape of the cuff.

The workflow of the study is shown in Figure 1.

Anaesthesia

The participants were not given any premedication. After obtaining the native MRI scans (see below), anaesthesia was induced on the MRI table immediately outside the MRI

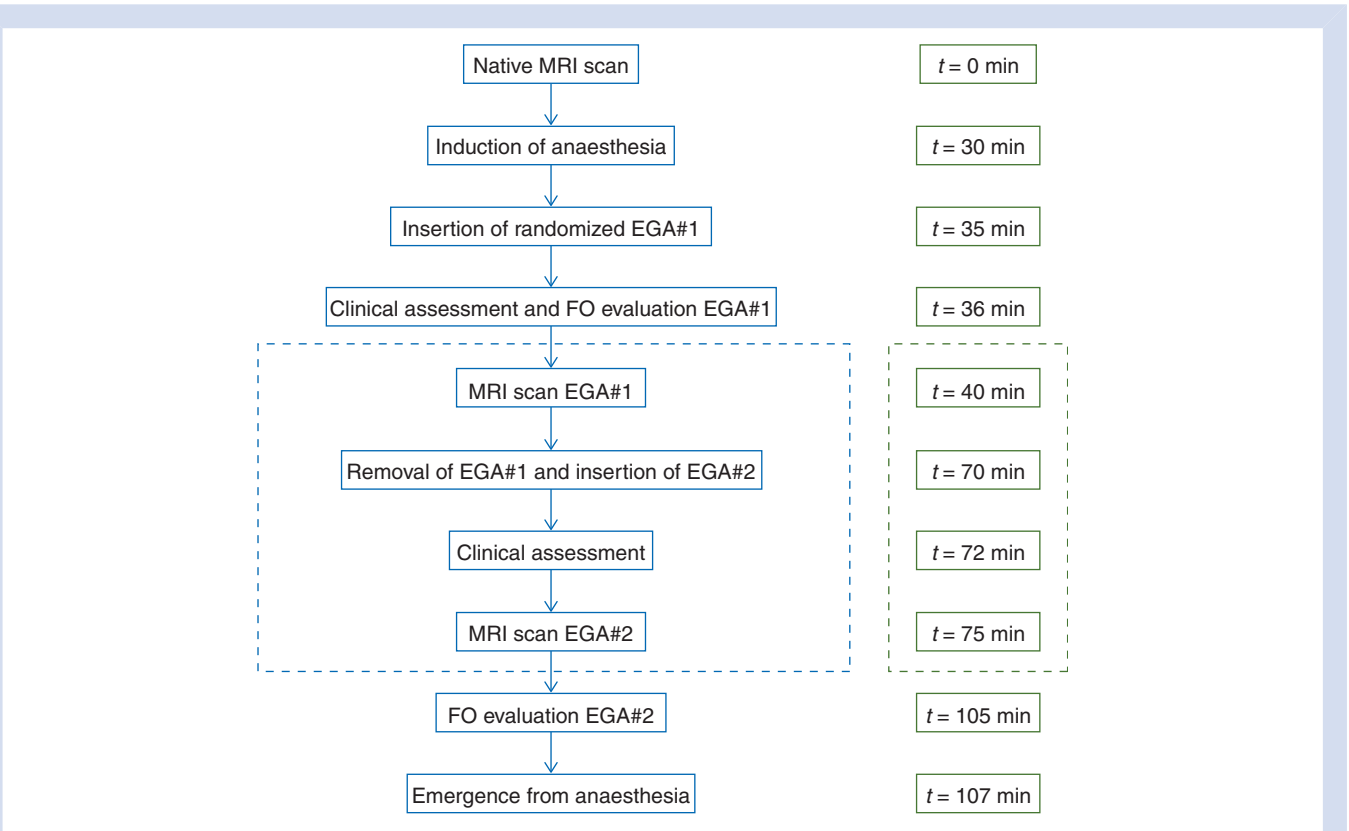

Fig 1 Study flow. Flow chart of the study progress. All steps indicated within the dashed box were performed in the MRI cabin. EGA, extraglottic airway device; FO, fibreoptic.