Tracheal intubation in patients with odontogenous abscesses and reduced mouth opening

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Editor’s key points
- Mouth opening is often reduced in patients with odontogenous abscesses.
- This can impair laryngoscopic view and make tracheal intubation difficult or impossible.
- The authors studied success rates and intubation duration with a conventional laryngoscope and a video laryngoscope.

Background. Odontogenous abscesses with involvement of the facial or cervical spaces can be life-threatening and often have to be drained under general anaesthesia. Trismus and swelling can make intubation with a Macintosh laryngoscope difficult or even impossible. However, indirect laryngoscopy has been successful when conventional direct laryngoscopy has failed. Therefore, we evaluated the efficacy of the Glidescope laryngoscope in patients with odontogenous abscesses and the improvement in mouth opening after neuromuscular block.

Methods. After approval of the ethics committee, 100 patients with odontogenous abscesses were randomized to undergo tracheal intubation with the Glidescope or Macintosh laryngoscope. Success rate, visualization of the glottis, intubation duration, and need for supporting manoeuvres were evaluated.

Results. Intubation with the Glidescope was always successful, while conventional intubation failed in 17 out of 50 patients ($P<0.0001$). In all patients in whom conventional tracheal intubation failed, a subsequent attempt with the Glidescope was successful. The view at the glottis (according to Cormack and Lehane; $P<0.0001$), intubation duration (34 s (CI 27–41) vs 67 s (CI 52–82), mean (95% confidence interval); $P=0.0001$), and need for supporting manoeuvres ($P<0.0001$) were significantly different. The inter-incisor distance improved overall with induction of anaesthesia from 2.0 cm (CI 1.8–2.2) to 2.6 cm (CI 2.3–2.9; $P<0.0001$) and was correlated with the duration of symptoms.

Conclusions. In patients with odontogenous abscesses, the use of a Glidescope laryngoscope was associated with significantly faster tracheal intubation, with a better view, fewer supporting manoeuvres, and a higher success rate than with a conventional laryngoscope. Improvement of the inter-incisor distance after induction of anaesthesia correlated with the duration of symptoms.

Keywords: intubation, difficult; intubation, tracheal; laryngoscope, Glidescope; laryngoscope, Macintosh

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Odontogenous abscesses can spread through facial and cervical spaces into the mediastinum and lead to life-threatening mediastinitis.1–5 Moreover, these abscesses can alter mouth opening and cause upper airway obstruction. Therefore, these abscesses have to be drained urgently, mostly under general anaesthesia. In these cases, tracheal intubation can be complicated by trismus, intraoral, and pharyngeal swelling and can be difficult or even impossible when performed with a Macintosh laryngoscope.1–3,6 However, the limited mouth opening is influenced by pain, swelling, and reflex contraction and might be partially or fully reversible after induction of general anaesthesia and neuromuscular block.

Over recent years, several indirect laryngoscopes have been developed to improve the view at the glottis and facilitate tracheal intubation.7–12 In many studies and case series, indirect laryngoscopes have been shown to be successful where conventional direct laryngoscopy failed.7–12 Therefore, the aim of the study was to evaluate the efficacy of the Glidescope laryngoscope for tracheal intubation of patients with odontogenous abscesses that had spread into the facial or cervical spaces, and had caused an inter-incisor distance of <3.5 cm. For comparison, we selected a Macintosh laryngoscope.

We also sought to explore the influence of pain, muscle relaxation, and other factors, on mouth opening.
Intubation and odontogenic abscesses

Methods

Subjects and patients

After approval by the local ethics committee (Chamber of Physicians of Northrhine, Düsseldorf, Germany; Registration Number: 2007160), 100 patients undergoing incision and drainage of an odontogenous abscess under general anaesthesia provided written informed consent to participate in this study.

The patients were older than 18 yr and presented to the preoperative evaluation centre with a mouth opening of 1.4 cm or more. Exclusion criteria included ASA physical status of IV or worse, requirement for rapid sequence induction, and factors causing a reduced tolerance for apnoea (such as morbid obesity, severe respiratory, or cardiac disease).

Only patients with an abscess of the deep facial or cervical spaces were included. Patients with a superficial abscess that could be drained intra-orally without drainage of the adjacent spaces were excluded. The patients were recruited from the department of oral and maxillo-facial surgery. Patients were randomized to be intubated with a Macintosh or Glidescope laryngoscope.

Methods

Before induction of anaesthesia, the inter-incisor distance during maximal active mouth opening was measured and the modified Mallampati score was assessed with the patient in the sitting position. For the assessment of the Mallampati score, the patients were asked to open their mouths as widely as possible and to protrude their tongues when possible. They were also asked to phonate. At tracheal intubation, visualization of the laryngeal entrance was assessed according to the classification of Cormack and Lehane: I, vocal cords visible; II, less than half of the glottis or only the posterior commissure is visible; III, only the epiglottis is visible; IV, none of the foregoing is visible.

The tracheal intubations were performed by one of the seven experienced attending anaesthetists with more than 2 yr of experience in anaesthesia for oral and maxillofacial surgery. All anaesthetists had performed more than 10 successful intubations with the Glidescope before they participated in the study.

The anaesthetists who performed the tracheal intubation were blinded to the randomization and were informed of the respective laryngoscope after the induction of general anaesthesia. To optimize tracheal intubation, they were permitted to perform one or more of: external manipulation of the larynx, change in the head position, and use of an Eschmann stylet (Portex, Smiths Medical, Hythe, Kent, UK), Magill forceps, or both.

The number of optimizing manoeuvres was analysed in four categories: category 1, no manoeuvres; category 2, 1 manoeuvre; category 3, 2 manoeuvres; and category 4, 3 manoeuvres. The sequence of the manoeuvres was left to the discretion of the intubating anaesthetist.

For tracheal intubation, a Glidescope or a Macintosh laryngoscope was used. The size of the tracheal tube (6.5–7.5 mm ID) was selected according to the discretion of the intubating anaesthetist, before being informed about the randomization allocation.

The Glidescope (GLV reusable, blade 4, Verathon Medical Europe, Ijsselstein, The Netherlands) is a laryngoscope with an integrated video camera and a blade that has an additional 60° upward angulation at the distal half of the blade. Signals from the camera are displayed on a portable monitor connected to the handle of the laryngoscope.

Protocol

Upon arrival in the induction room, a peripheral i.v. cannula was inserted and standard monitoring (three-lead ECG, non-invasive arterial pressure measurement, finger tip for arterial oxygen saturation) was applied. Patients were placed in a supine position with their head placed on a 7 cm headrest. Next, preoxygenation was performed (FiO₂ of 1.0). The induction of general anaesthesia was performed with propofol, remifentanil, and succinylcholine, at doses selected according to the discretion of the attending anaesthetist. Mask ventilation was performed at the discretion of the attending anaesthetist.

Finally, the randomization was revealed and the attending anaesthetist started the intubation attempt. The duration of the complete intubation attempt was measured as the time from the opening of the mouth until the time of inflation of the tracheal tube cuff.

The attending anaesthetist noted the best laryngoscopic view according to the Cormack and Lehane classification. If the anaesthetist did not succeed with the intubation despite all manoeuvres, the intubation attempt was regarded as failed. No more than three intubation attempts were allowed. Once the attempt was declared as failed, the anaesthetist attempted to intubate the trachea using the non-randomized instrument. In cases where all attempts failed, the patients were to be awakened and intubated using a fibreoptic endoscope. Vital parameters before induction of anaesthesia and at the end of the intubation were recorded.

Data analysis

Data are presented as mean and 95% confidence interval (CI). Sample size calculation was based on the primary hypothesis that there is no significant difference in the success rate for tracheal intubation with either a standard Macintosh or a Glidescope laryngoscope. Based on an α-error of 0.05, a β-error of 0.8, an expected success rate with the Macintosh laryngoscope of 80%, and a clinically significant difference in success being regarded as 15%, we calculated that 38 patients per group were required. We rounded the number to 50 for each laryngoscope.

In addition, three exploratory hypotheses were tested. First, that there is no difference between the two laryngoscopes in the duration of tracheal intubation. Secondly, that the view at the larynx according to Cormack and Lehane is not different between the two laryngoscopes. Thirdly, there is no
difference in the need for optimizing manoeuvres between the two techniques.

In addition, the gain in the inter-incisor distance after induction of general anaesthesia and neuromuscular block was assessed and correlated with the duration of symptoms and the number of spaces involved.

Hypotheses were tested using the $\chi^2$ test (success rate of tracheal intubation, visualization of the glottis according to Cormack and Lehane, need for optimizing manoeuvres) and Student’s t-test (intubation duration). Differences were considered significant for $P<0.05$.

**Results**

**Patient characteristics, induction agents for general anaesthesia**

There was neither a significant difference in the anthropometric data of the patients nor in the use of the induction agents for anaesthesia (Table 1). In particular, the criteria that might predict difficult intubation were not different between the groups. Enrolment of the patients is presented in a CONSORT diagram (Fig. 1).

**View according to Cormack and Lehane and optimizing manoeuvres**

The view at the glottis according to the classification of Cormack and Lehane was significantly better for the Glidescope than the Macintosh laryngoscope (Fig. 2). Significantly fewer optimizing manoeuvres were needed when the Glidescope laryngoscope was used (31/13/6/0 for Glidescope and 12/17/4/17 for Macintosh; $P<0.0001$). Details are presented in Tables 2 and 3.

**Time and success rate for tracheal intubation**

In all of the patients randomized for the Glidescope laryngoscope, tracheal intubation was successful; whereas in 17 patients out of 50 randomized for the Macintosh laryngoscope, tracheal intubation failed ($P<0.0001$). Among the 17 patients in whom intubation failed with the Macintosh laryngoscope, subsequent intubation with the Glidescope laryngoscope was successful.

Time duration of intubation was analysed with and without inclusion of the failed attempts ($P<0.0001$). When intubation duration was analysed without the failed attempts, intubation with the Glidescope laryngoscope was significantly faster [Macintosh 56 s (CI 42–70) vs Glidescope 34 s (CI 27–41); $P=0.0062$]. When failed attempts were set at the time duration of the longest successful intubation (135 s), the results became even clearer [Macintosh 67 s (CI 42–82) vs Glidescope 34 s (CI 27–41); $P=0.0001$, Fig. 3]. The mean difference in intubation duration was 33 s (CI 17–49).

**Preoperative and post-induction mouth opening**

The results of preoperative and post-induction mouth opening measurements are presented in Table 1. When the abscess location was classified as recommended by Darshane and colleagues into masseteric, floor of mouth, and parapharyngeal spaces, 67 abscesses were limited to one region, 31 spread over two regions, and two abscesses reached all three regions. In patients where only one location was involved, there were no differences between locations in the change of mouth opening. There was however a significant difference in the change of mouth opening when more than one region was affected ($P=0.0005$, Fig. 4). The gain in mouth opening decreased from 1.0 cm (CI 0.8–1.2) for patients with one affected region to 0.6 cm (CI 0.5–0.7) for patients with more than one affected region.

There was no difference in the duration of symptoms between the two groups [Macintosh 4.8 days (CI 4.1–5.5) vs Glidescope 4.9 days (CI 4.2–5.6); $P=0.8033$]. The duration of symptoms correlated with the gain in mouth opening ($r=0.74$; Fig. 5). Patients whose symptoms had lasted <3 days had an improvement in mouth opening of >9 mm after induction of anaesthesia. From the third day on, 55% of the patients had an improvement in mouth opening of ≤5 mm.

**Haemodynamic effects and arterial haemoglobin oxygen saturation during tracheal intubation**

None of the patients developed haemodynamic changes that required intervention. Two patients in each group developed a transient desaturation to below 90%. The lowest observed arterial oxygen saturation was 86% for both techniques.

**Discussion**

In patients with a facio- or cervical space abscess and a mouth opening of <3.5 cm, the Glidescope laryngoscope provided a significantly better success rate, in a shorter time, and a better view of the glottis compared with a standard Macintosh laryngoscope. The gain in mouth opening after induction of anaesthesia was dependent on the duration of symptoms.

Studies on difficult intubations are hampered by the fact that an intubation can only be regarded as difficult after intubation has been attempted. Therefore, randomization of patients with an even distribution of risk factors for difficult intubation is crucial for a comparison of different laryngoscopes.

### Table 1 Characteristics of 100 patients (mean; 95% confidence interval, CI) intubated with a Macintosh (n=50) or Glidescope (n=50) laryngoscope

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Macintosh</th>
<th>Glidescope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm; CI)</td>
<td>174 (171–177)</td>
<td>173 (170–176)</td>
</tr>
<tr>
<td>Weight (kg; CI)</td>
<td>80 (75–85)</td>
<td>81 (74–88)</td>
</tr>
<tr>
<td>Age (yr; range)</td>
<td>44 (22–87)</td>
<td>44 (18–75)</td>
</tr>
<tr>
<td>Propofol (mg kg$^{-1}$; CI)</td>
<td>3.8 (3.5–4.1)</td>
<td>3.6 (3.3–3.9)</td>
</tr>
<tr>
<td>Remifentanil (µg kg$^{-1}$; CI)</td>
<td>0.9 (0.8–1.0)</td>
<td>1.0 (0.9–1.1)</td>
</tr>
<tr>
<td>Succinylcholine (mg kg$^{-1}$; CI)</td>
<td>1.2 (1.1–1.3)</td>
<td>1.2 (1.1–1.3)</td>
</tr>
<tr>
<td>Mallampati score (I/II/III/IV)</td>
<td>0/17/30</td>
<td>0/12/37</td>
</tr>
<tr>
<td>Thyromental distance (cm; CI)</td>
<td>6.9 (6.1–7.3)</td>
<td>7.1 (6.6–7.5)</td>
</tr>
<tr>
<td>Mouth opening before (cm; CI)</td>
<td>2.0 (1.8–2.2)</td>
<td>1.8 (1.6–2.0)</td>
</tr>
<tr>
<td>Mouth opening after (cm; CI)</td>
<td>2.8 (2.5–3.1)</td>
<td>2.7 (2.5–2.9)</td>
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</table>
In the patients we studied, risk factors such as mouth opening, Mallampati score, duration of symptoms, and number of spaces involved were not different between groups, and therefore, we believe that our study design and patient cohort were adequate to test our hypotheses.

Deep facial and cervical space abscesses can lead to a reduction in mouth opening that does not improve significantly after neuromuscular block. In addition, intra-oral and pharyngeal swelling and rigidity of the floor of mouth can further increase the intubation difficulty. Therefore, attempted tracheal intubation with a standard Macintosh laryngoscope under general anaesthesia in patients with odentogenous abscesses and a spread of the infection into facial or cervical spaces can lead to disastrous and life-threatening situations.

Several studies in manikins and patients have documented that the Glidescope laryngoscope facilitates a better view of the glottis and a higher success rate of tracheal intubation compared with a Macintosh laryngoscope in adults and children. However, it is unclear if these results apply to patients with deep facial and cervical abscesses.

Our results demonstrate that in patients where mouth opening was sufficient for introduction of the Glidescope blade, the indirect view (via the Glidescope camera) around the floor of mouth made a tracheal intubation possible, although in five patients, the view of the larynx was at best a C&L grade 3 view. Moreover, in all of the patients where intubation with a Macintosh laryngoscope was impossible, intubation with the Glidescope was feasible. Nevertheless, although all 67 intubation attempts with the Glidescope were successful, this (arguably low number of intubation attempts) does not exclude the possibility of failed intubations with this instrument in other patients. Therefore, all of these cases require thorough planning before induction as presented in Darshane’s concept of ‘responsive contingency planning’.

Taking patient safety into account, the duration of intubation attempts was not limited to a certain time but was left to the discretion of the attending anaesthetist. In cases where the anaesthetist was not able to accomplish the intubation, it would not have made sense to prolong a failed attempt by insisting on a certain time limit. In the analysis of intubation duration, exclusion of data from patients in whom intubation with the Macintosh instrument failed can cause a bias by reducing the mean duration in this group. Thus, failed intubations were regarded as having taken as long as the longest successful intubation. However, even when the failed intubations with the Macintosh laryngoscope were excluded from analysis,
intubation duration was still significantly shorter for the Glide- scope technique.

Besides intra-oral and pharyngeal swelling, a reduction in mouth opening determines the intubation conditions. In awake patients, a reduced mouth opening can be caused by pain, reflex contraction, and swelling, which hinder forward movement of the mandible. If most of the reduction is pain related, then a significant improvement can be expected after induction of anaesthesia and neuromuscular block. To evaluate the factors that might influence the gain in mouth opening after induction of anaesthesia, we analysed the duration of symptoms as an approximation of the duration of the infection and the spread of the infection by looking at the areas involved. In a modification of the classification of Darshane and colleagues,1 we grouped the spaces into masticator spaces (submasseteric, pterygomandibular, and temporal spaces), floor of mouth (submental, sublingual, and submandibular spaces), and parapharyngeal spaces. There was no difference in gain among patients in whom the masticator space and floor of mouth spaces were involved compared with patients where only one space was involved. With differences in swelling and exact location of the abscess, every deep abscess can be considered unique, and thus careful planning of the induction is required.2 As expected, intubation conditions worsened when the infection had spread over more than one region.

We found a correlation between the duration of symptoms and mouth opening. When the duration lasted ≤3 days, an improvement of mouth opening of >9 mm was always found (n = 20). Among patients presenting with symptoms lasting ≥3 days, 55% (n = 44) had a gain in mouth opening after induction of anaesthesia of ≤5 mm, whereas only 45% (n = 36) showed an improvement of >5 mm.

These results could have been influenced by the selection of the patients and differences in the depth of anaesthesia, which are important determinants of the intubation. Therefore, we analysed the characteristics of the patients (Table 1) and the medication used for induction of anaesthesia. We found no significant difference. To minimize the influence of anaesthesia, the choice of
the respective laryngoscope was only revealed after the induction of anaesthesia just before the intubation attempt started.

Our study was limited by the focus on patients with a mouth opening between 1.5 and 3.5 cm and patients with an involvement of facial or cervical spaces. An improvement in mouth opening was significantly decreased when more than one region was involved.

In addition, to avoid the risk of a failure to intubate patients after neuromuscular block, we excluded patients with a mouth opening of <1.5 cm (in these patients, fibreoptic tracheal intubation was performed under sedation and local anaesthesia).

Furthermore, we limited our analysis to mouth opening and neglected other aspects that could indicate a difficult intubation such as rigidity of the floor of mouth, limited neck extension, blocked nostrils, drooling, or cellulitis affecting the anterior neck. Each of these criteria gives additional information about a potentially difficult intubation. However, these criteria are more difficult to quantify and not as reproducible as a simple measurement in centimetres. Therefore, we focused on the mouth opening and the comparison between the two laryngoscopes.

Overall, we conclude that in patients with odontogenous abscesses, tracheal intubation was performed significantly faster with a better view and a higher success rate with a Glidescope laryngoscope. All patients of the group randomized for the Glidescope laryngoscope were intubated successfully. In addition, in a crossover design, in all patients with a failed Macintosh attempt, subsequent tracheal intubation with the Glidescope laryngoscope was successful. Improvement of the mouth opening after induction of anaesthesia correlated with the duration of symptoms.

Authors’ contributions
M.S. collected the data and performed the measurements and the first statistical calculations and contributed to the study proposal and the final manuscript. I.B. and A.B. both equally contributed to the development of the study design and supervised the correct clinical adherence to the protocol. Finally, both contributed to the manuscript. R.P. and C.M. gave their surgical input to the study design and took care of the correct interpretation of the surgical data about the abscesses and procedures. H.G. initiated the study, wrote the study proposal for the ethics committee, calculated the final statistics, and wrote the main part of the manuscript and revision. In addition, I.B., A.B., and H.G. are three of the seven anaesthetists who managed the intubations.

Declaration of interest
None declared.

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