

Eye Movements in the Operating Room: The Effect of a 3D Endoscope on Experts' and Novices' Fixation Duration

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Introduction

- Eye movements in minimal invasive surgery (MIS) provide a valuable insight into surgeons' perception process.
- Because surgeons can only see their hand movements on a screen, eye-hand coordination is crucial and thus their gaze offers subsidiary information about their focus and strategy.
- Studies in MIS suggest that surgeons with high experience show longer fixations compared to novices (Eivazi et al., 2017).
- Specifically in goal-relevant areas, experts fixated significantly longer, indicating a more focused approach for experts compared to novices (Sodergren et al., 2011; Wilson et al., 2011).
- With recent technical progress, a new 3-dimensional endoscope has become available additional to the conventional 2-dimensional endoscope.
- The 3D endoscope should facilitate perception of the image since a translation from the 2-dimensional image is no longer necessary .
- To date however, no elaborate validation of its effects on surgeons has yet been done.

How does the 3-dimensional endoscope affect the surgeons' fixation duration during an endoscopic ear surgery?

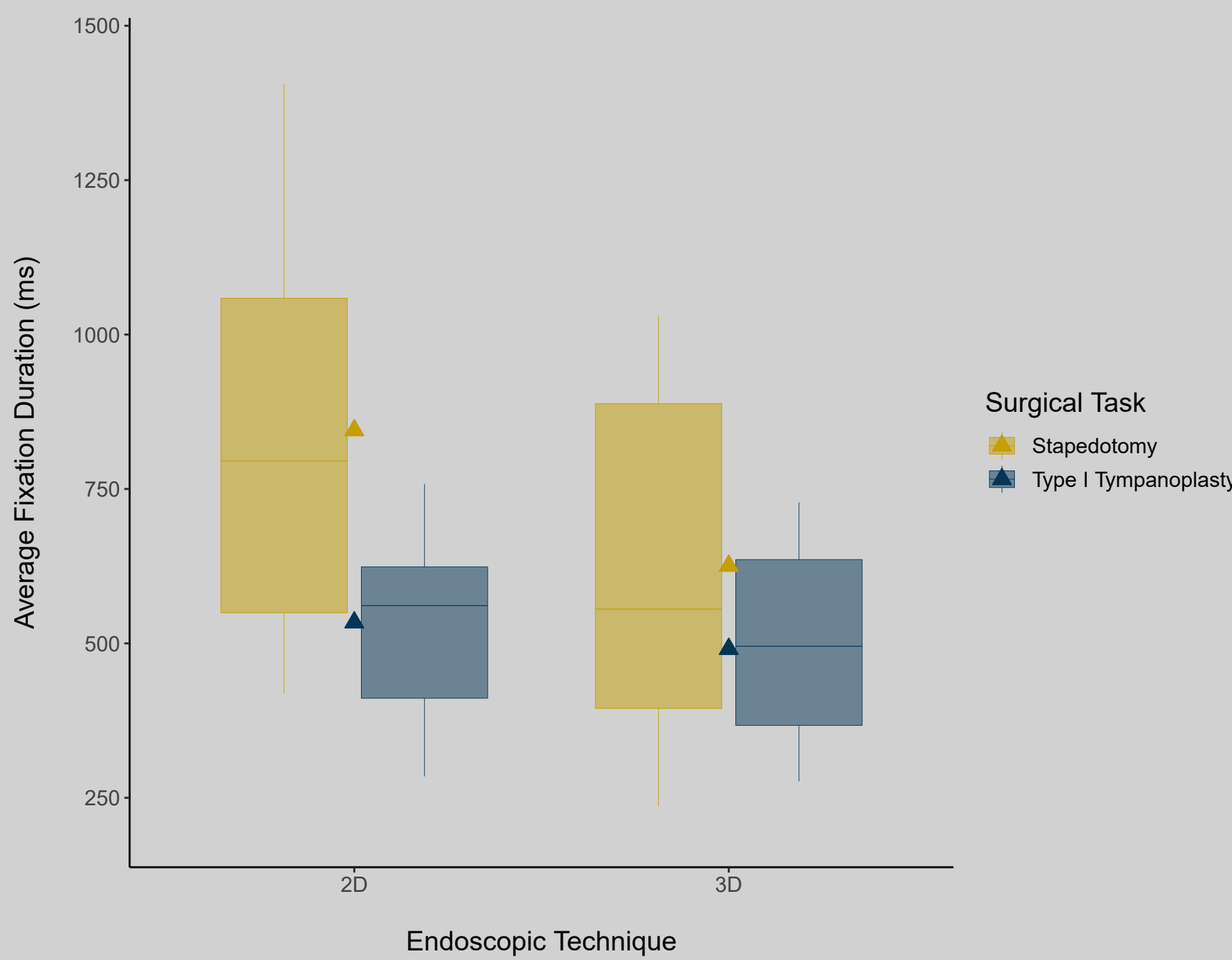
Methods

- Subjects
16 surgeons (5 experts and 11 novices) of the Department of Otorhinolaryngology, Head & Neck Surgery, Inselspital Bern, Switzerland (mean age: 36 years)
- Participants performed selected steps of two endoscopic surgeries (Type I Tympanoplasty and Stapedotomy) with a 2D endoscope and a 3D endoscope in a cadaveric model.
- Four trials in total, randomised with a Latin square.
- Surgeons' eye-movements were recorded with a head-mounted eye-tracking device (SensoMotoric Instruments (SMI), Berlin, Germany).
- The eye-tracker had a gaze position accuracy of 0.5° and a frame rate of 60 Hz and was calibrated before each trial.
- We used the SMI BeGaze Analysis software version 3.7 (SMI, Berlin, Germany) for computation of fixation durations (average duration of fixations per trial).
- We analysed fixation duration by means of a Bayesian Generalized Linear Mixed Model (using a lognormal regression model).

Results

A) There was a significant interaction between endoscopic technique and experience ($\beta = 0.44$; 95% CI: 0.10 to 0.77): Whereas experts fixated longer than novices when using the 2D endoscope, no such difference was found with the 3D endoscope.

B) There was a significant interaction between endoscopic technique and surgical task ($\beta = 0.53$; 95% CI: 0.15 to 0.91): Participants showed longer fixations in the Stapedotomy task than in the Type I Tympanoplasty task when using the 2D endoscope, but this difference decreased with the 3D endoscope.



Figures: Duration of eye fixation in ms specified by endoscopic technique for the different experience levels (A) and different tasks (B). The upper and lower boundaries of the boxplots are at the 25th and 75th percentiles. The horizontal lines indicate median values, and the triangles indicate mean values. The whiskers extend from the box to the highest/lowest value that is within 1.5 of the IQR (inter quartile range). The points display outliers.

Conclusion

- The endoscopic technique has a notable effect on surgeons' eye fixations.
- Results indicate that surgeons with high experience are particularly affected by the 3D endoscope as they cannot apply their usual focused and steady gaze.
- Results also suggest that the effect of the endoscope varies with different surgical tasks.

References
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