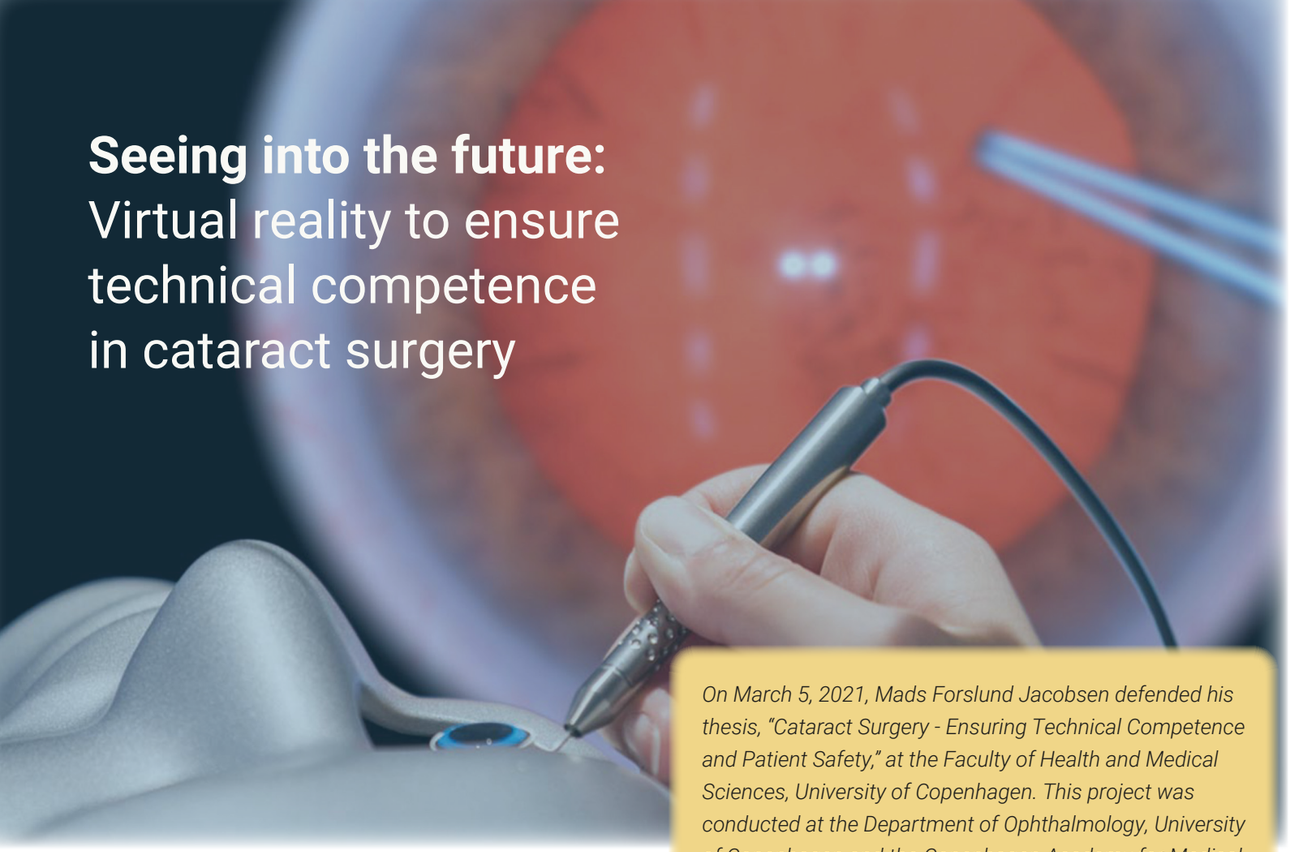
Seeing into the future: Virtual reality to ensure technical competence in cataract surgery



On March 5, 2021, Mads Forslund Jacobsen defended his thesis, "Cataract Surgery - Ensuring Technical Competence and Patient Safety," at the Faculty of Health and Medical Sciences, University of Copenhagen. This project was conducted at the Department of Ophthalmology, University of Copenhagen and the Copenhagen Academy for Medical Education and Simulation under the supervision of Professor Morten la Cour, Professor Lars Konge, Ann Sofia Skou Thomsen, MD, PhD, and Lars Holm, MD, PhD.

Virtual reality simulation training has been incorporated into the education of ophthalmic surgeons, including cataract surgeons, worldwide. Previous studies have shown that virtual reality simulation training can reduce the complication rate and improve the technical proficiency of novice cataract surgeons in the operating room. Despite these findings, there is a risk that virtual reality simulation is not being utilized to its full potential. In particular, three areas need clarification: (1) Can virtual reality simulation serve a purpose in the assessment of cataract surgical skill? (2) Can we develop a virtual reality simulated test designed for more experienced cataract surgeons? (3) Is it possible to optimize the way we measure surgical proficiency and the effects of educational interventions, such as virtual reality simulation training? These are the questions we have sought to answer in this PhD project.

In Paper I, we investigated the correlation between virtual reality simulator performance and performance in the operating room for 19 cataract surgeons with varying experience levels. We found a statistically significant correlation between the two and discussed the use of virtual reality simulation as a tool for the assessment of proficiency in cataract surgery.

In Paper II, we developed a virtual reality simulator test designed for more experienced cataract surgeons, to assess proficiency in handling complications and difficult clinical cases. We investigated the test for evidence of validity by registering how 20 cataract surgeons and residents performed. We demonstrated evidence of validity within multiple aspects of a modern validity framework. On this foundation, we conclude that although the test cannot be used for certification of more experienced cataract surgeons, the advanced simulator modules may still be relevant for training purposes.

In Paper III, we aimed to optimize how we assess cataract surgical proficiency and measure the effects of educational interventions. We investigated which patient-related outcomes are dependent on surgical experience. We included 128 patients operated on by experienced and inexperienced cataract surgeons and found that visual acuity, central corneal thickness, and complication rates were dependent on the experience of the surgeon. These variables may serve as manageable and effective outcomes for planning educational interventions and measuring their effects.

In conclusion, virtual reality simulation, from a theoretical standpoint, could be a valuable tool in the assessment of cataract surgical proficiency. In addition, although our advanced cataract surgical test is not suited for certification purposes, the road has been paved for investigating whether more experienced cataract surgeons could benefit from training using these advanced cataract surgery simulator modules. Finally, we have defined which patient-related outcomes are dependent on the experience of the surgeon. Our findings suggest that visual acuity, central corneal thickness, and complication rates may be used to assess cataract surgical skill and measure the effects of training interventions.

Left: The EyeSi Surgical by Haag-Streit Simulation is a high-fidelity, virtual reality, surgical simulator that can be equipped with both cataract and vitreoretinal surgical interfaces. It offers training of basic skills as well as surgical procedures, and helps surgeons practice how to manage complications.

Remaining questions:

- Can this technology be used in the education of not only novice, but also more experienced cataract surgeons?
- Can we use the outcome measures suggested by our studies to investigate the effects of VR-based simulation training directly in the tissue of the patients?

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Key points:

- Simulator performance was significantly correlated with real-life cataract surgical performance.
- It's possible to develop a test for more experienced surgeons. Simulator modules could aid in the training of advanced cataract surgical skill.
- Variables such as visual acuity, central corneal thickness, and surgical complications make up the cataract surgical footprint and are dependent on the experience of the surgeon.

Articles in the dissertation

1. Jacobsen MF, et al. Virtual-Reality performance correlates significantly with real-life cataract surgical performance. *J Cataract Refract Surg.* 2019;45(9), 1246-1251.
2. Jacobsen MF, et al. Simulation of advanced cataract surgery - validation of a newly developed test. *Acta Ophthalmol.*2020;98(7):687-692.
3. Jacobsen MF, et al. Defining the surgical footprint in cataract surgery: patient-related outcomes dependent on the experience of the surgeon. *Acta Ophthalmol.* 2020. doi: 10.1111/aos.14733. Epub ahead of print.