# WHICH VIDEO TECHNOLOGY BRINGS THE HIGHER COGNITIVE BURDEN AND MOTION SICKNESS IN LAPAROSCOPIC COLORECTAL SURGERY: 3D, 2D-4K OR 3D-4K? A PROPENSITY SCORE STUDY

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**Background**:
Technological development has offered laparoscopic colorectal surgeons new video systems to improve depth perception and perform difficult task in limited space.
The first of these newly developed systems is the three-dimensional (3D) video, similar to that used in cinematography as well as for military applications. It was introduced back in the 90's in surgery, but in the early phase it suffered from several shortcomings, including low brightness/resolution and the need for bulky/heavy glasses which made its use really uncomfortable for the surgeon [1, 2]. New developments have allowed, since then, a significant improvement in comfort for the operating surgeon [3,4]. They have proved to be particularly helpful in assisting surgeons in precise tasks such as suturing or knotting, when the spatial perception is particularly important [4-6]. 3D laparoscopic systems have therefore re-gained in popularity and their use has been diffused in most surgical units [7].
4K video systems are based on 2D ultra-high display technique and provide magnification of the surgical field up to 30 times on very large screens. This is meant to improve surgical performance [8,9].
3D-4K represents a combination of characteristics of the two video systems and is now the third option available in terms of new imaging technologies for laparoscopic surgery.

**Aim:**
The aim of this study was to assess the cognitive burden and motion sickness for surgeons during 3D, 3D-4K or 2D-4K laparoscopic colorectal procedures and to report post-operative data with the different video systems employed.

**Methods**:
Patients were assigned to either 3D, 3D-4K or 2D-4K video and two questionnaires (Simulator Sickness Questionnaire-SSQ- and NASA Task Load Index -TLX) were used to collect data on cognitive burden and motion sickness during elective laparoscopic colorectal resections (October 2020-August 2022) from two operating surgeons. Short-term results of the operations performed with the three different video systems were also analyzed.

**Results**: A total of 113 consecutive patients were included: 41 (36%) in the 3D Group (A), 46 (41%) in the 3D-4K Group and 26 (23%) in the 2D-4K Group (C). Weighted and adjusted regression models showed no significant difference in cognitive load amongst the surgeons in the three groups of video systems when using the NASA-TLX. An increased risk for slight/moderate general discomfort and eyestrain in the 3D-4K group compared with 2D-4K group (OR= 3.5; $p$ = 0.0057 and OR = 2.8; $p$ = 0.0096, respectively) was observed. Further, slight/moderate difficulty concentrating was lower in both 3D and 3D-4K groups compared with 2D-4K group (OR= 0.4; $p$ = 0.0124 and OR =0.5; $p$ = 0.0341, respectively), and higher in the

3D-4K group compared with 3D group (OR= 2.6; $p$ = 0.0124). Patient population characteristics as well as operative time, post-operative staging, complication rate and length of stay were similar in the three groups of patients.

**Conclusions**: 3D and 3D-4K systems, when compared with 2D-4K video technology, have a higher risk for slight/moderate general discomfort and eyestrain, but show lower difficulty concentrating. Short post-operative outcomes do not differ, whichever imaging system is used.

**References**


1. Herron D. M., Lantis II J. C., Mayke, J. et al., *The 3-D monitor and head-mounted display: A quantitative evaluation of advanced laparoscopic viewing technologies.* Surg. Endosc. 13, 751–755 (1999).
2. Mueller M. D., Camartin C., Dreher E. & Hänggi W, *Three-dimensional laparoscopy. Gadget or progress? A randomized trial on the efficacy of three-dimensional laparoscopy*. Surg. Endosc. 13, 469–472 (1999).
3. Usta T. A., Ozkaynak A., Kovalak E. et al, *An assessment of the new generation three-dimensional high definition laparoscopic vision system on surgical skills: a randomized prospective study*, Surg. Endosc. 29, 2305–2313 (2015).
4. Feng X., Morandi A., Boehne M. et al, *3-Dimensional (3D) laparoscopy improves operating time in small spaces without impact on hemodynamics and psychomental stress parameters of the surgeon*. Surg. Endosc. 29, 1231–1239 (2015).
5. Vettoretto N., Reggiani L., Cirocchi R. et al., *Three-dimensional versus two-dimensional laparoscopic right colectomy: a systematic review and meta-analysis*. Int. J. Colorectal Dis. 33, 1799–1801 (2018).
6. Zeng Q., Lei F., Gao Z. et al., *Case-matched study of short-term effects of 3D vs 2D laparoscopic radical resection of rectal cancer.* World J. Surg. Oncol. 15, 178 (2017).
7. Anania G., Agresta F., Artioli E. et al., *Laparoscopic right hemicolectomy: the SICE (Società Italiana di Chirurgia Endoscopica e Nuove Tecnologie) network prospective trial on 1225 cases comparing intra corporeal versus extra corporeal ileo-colic side-to-side anastomosis*. Surg. Endosc. 34, 4788–4800 (2020).
8. Wahba R., Datta R., Bußhoff J. et al., *3D Versus 4K Display System - Influence of 'State-of-the-art'-Display Technique on Surgical Performance (IDOSP-study) in Minimally Invasive Surgery: A Randomized Cross-over Trial.* Ann. Surg. 272, 709–714 (2020).
9. Harada H., Kanaji S., Hasegawa H. et al., *The effect on surgical skills of expert surgeons using 3D/HD and 2D/4K resolution monitors in laparoscopic phantom tasks.* Surg. Endosc. 32, 4228–4234 (2018).