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Evaluation of ergonomics and surgeon's stress levels during robotic assisted minimally invasive surgery using a new hybrid robot (Dexter)

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Background

Although often forgotten and underestimated, especially in a surgical work environment, ergonomics are essential for endurance, efficiency and a long and healthy work life. While many ergonomic challenges faced in open and laparoscopic surgery have been overcome by robotic surgery, new challenges have been created. Nationwide and international guidelines for implementation of an ergonomic workspace are currently lacking. This study aims to identify ergonomic characteristics of a new hybrid robotic system during a standardized procedure to lay the foundation for a healthy workspace.

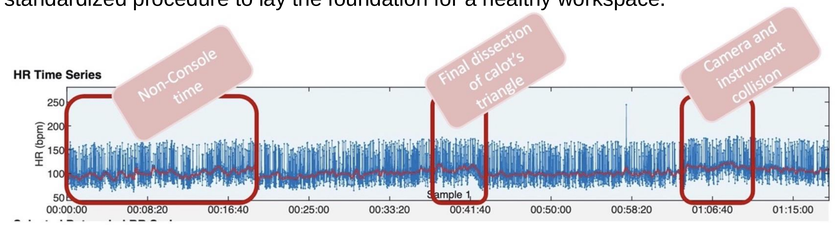


Fig 3: *Correlation of heart rate with the intraoperative course. An elevated hear rate was observed during non-console time, final dissection of the calot's triangle and instrument collision. .*

Methods

Measurements were performed during a real-life case of a robotic cholecystectomy performed by an experienced robotic surgeon. A video camera was used to capture the surgeon at the console during surgery and is positioned in a 90° angle towards the surgeo so that the armrest of the console and the optimal position of the forearms are horizontal in the image (figure1). For evaluation of the images, axes are placed through the joints of the surgeon and corresponding angles are calculated based on the position of the individual axes in relation to each other and compared to recommendations for a healthy workspace. To evaluate the objective stress level of the surgeon the heart rate variability (HRV) was measured using a chest strap and analyzed using specific scientific software. Furthermore, sound level measurement was performed to evaluate the noise level in the OR. Data was further correlated with the intraoperative course and surgical performance.



Fig 1: *The video camera is positioned in a 90° angle towards the surgeon so that the armrest of the console is horizontal in the image*

	Surgery 1	Surgery 2
Heart rate	103	103
Minimum Heart rate	68	79
Maximum Heart rate	136	124
PNS* index	2	-2.19
SNS* index	1.89	2.92
Stress index	7.5	11.9

Tab. 2 *Measurement of heart rate and stress indices during robotic cholecystectomy.*

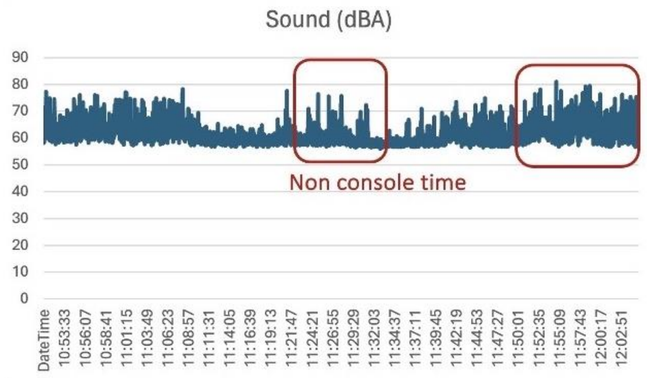


Fig. 2: *Figure 2: Comparison of sound level during console and non-console time.*

Results

N=2 robotic cholecystectomies performed by the same experienced surgeon were measured. Mean sound level was 63.5dB for the first case(range 57.5dB–77.3dB) and a mean of 61.2dB for the second case (range 55.3dB–82dB). Correlation of console versus non console time is showcased in figure2. Mean posture during both procedures in correlation to recommendations for a safe workplace are shown in table1. Mean heartrate, HRV and stress indices are shown in table2. Furthermore, figure3 shows the correlation of heart rate and the intraoperative course.

	Posture						
	Knee	**Hip**	**Shoulder**	**Neck**	**Elbow**	**Back**	**Forearm**
Mean (°)	117.8	102.3	45.3	33.3	119.6	1.5	14.1
Median (°)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Range (°)	110.8 – 124.8	98.1 – 106.5	43.5 – 47	32.2 – 34.4	113.1 – 126.1	1.1 – 2	8.9 – 19.3
	Knee	**Hip**	**Shoulder**	**Neck**	**Elbow**	**Back**	**Forearm**
Recommendation (°)	≥ 90	110-120	N/A	10-15	≥ 90	0-10	N/A
Within recommendation	Yes	No	N/A	No	Yes	Yes	N/A

Tab.1: *Posture of the surgeon during robotic cholecystectomy compared to recommendations for a safe workplace.*

Conclusion

A variety of different robotic systems do not only offer a variety of technical features and advantages but also differ in ergonomic requirements. The neck can be identified as an area of need for improvement for most systems. Future studies, especially in a randomized controlled fashion need to be performed to further analyze ergonomic features of the different systems and guidelines displaying the variety of systems need to be implemented to create a healthy and safe workplace.
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