Comparison of Short-term Outcomes Using Rigid Endoscope and Flexible Endoscope of 3D Imaging Technology

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Introduction

Minimally invasive surgery is becoming more common in current surgical procedures; however, The current state-of-the-art is dual-lens 3D stereo endoscopy which synthesizes a stereo image from the images obtained with lens enclosed in a single endoscope tube. Such system has limitations including not simulating the convergence of human eyes, not suitable for wide angle camera, and expensive. Therefore, we propose a 3D MonoStereo® system that utilizes existing 2D endoscopic systems to render real-time stereoscopic images during surgeries.



Fig. 1 3D MonoStereo® equipment installation

Methods and Procedures

This study retrospectively reviewed and analyzed the medical charts. Patients who underwent 3D endoscopic surgery from March to June 2020 are the subjects of this study. We collected surgeons' feedback data for statistical analysis to compare benefit of rigid endoscope and flexible endoscope. All statistical analyses were performed using SPSS version 24 and p value of < 0.05 was considered to be statistically significant.

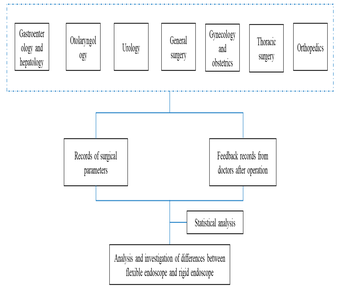


Fig. 2 Records of surgical parameters

Item	Very good	Good	Average	Poor	Very poor
1.3D images improve the speed and safety of surgery					
2.It is easier to grasp and cut tissues directly when viewing 3D images than 2D images.					
3.3D images provide better stereoscopic representation of organs and tissues as well as relative positions of movement compared with 2D images.					
4.Hand-eye coordination and image fluency during surgery					
5. Sense of delay in 3D images					
6.Comfort of viewing 3D images					
Experience & suggestions					

Table 1 Feedback records from doctors after operation

Results

As shown in Table 2, the results revealed that the use of flexible endoscopes in the divisions of gastroenterology and hepatology was as high as 99.9%, while rigid endoscopes were used more often in the urology general surgery divisions, at 34.0% and 35.2%, respectively. The performance P values of flexible and rigid endoscopes in different departments were <0.001, showing significant differences.

	Flexible endoscope		Rigid endoscope		Total			
	N	%	N	%	N	%	χ^2	p
Surgery departments							790.469	<0.001
Gastroenterology and hepatology	832	99.9%	6	3.7%	838	84.2%		
Otolaryngology	0	0.0%	14	8.6%	14	1.4%		
Urology	0	0.0%	55	34.0%	55	5.5%		
General surgery	0	0.0%	57	35.2%	57	5.7%		
Gynecology and obstetrics	0	0.0%	11	6.8%	11	1.1%		
Thoracic surgery	0	0.0%	10	6.2%	10	1.0%		
Orthopedics	0	0.0%	7	4.3%	7	0.7%		
Other departments	1	0.1%	2	1.2%	3	0.3%		

Table 2 Statistical analysis data from surgical departments

Table 3 shows the statistical analysis results of stereoscopic depth of field. The flexible endoscope was commonly used at Level 3, with a usage percentage of 62.8%, followed by Level 5, with a usage percentage of 17.2%, while the rigid endoscope was commonly used at Level 3, with a usage percentage of 34.0%, followed by Level 4, with a usage percentage of 26.5%.

	Flexible endoscope		Rigid endoscope		Total			
	N	%	N	%	N	%	X^2	p
Which mode and 3D level are most commonly used during surgery?							521.091	<0.001
2D Mode Most	105	12.7%	26	16.0%	131	13.2%		
Level 1	51	6.1%	8	4.9%	59	5.9%		
Level 2	521	62.8%	13	8.0%	534	53.8%		
Level 3	9	1.1%	55	34.0%	64	6.5%		
Level 4	1	0.1%	43	26.5%	44	4.4%		
Level 5	143	17.2%	17	10.5%	160	16.1%		

Table 3 Statistical data analysis of stereoscopic depth of field

The analysis results of the comprehensive statistical data on stereoscopic comfort and fluency scores (Table 4) showed that the P value was >0.05, suggesting that although the average score of rigid endoscopes was high, there was no significant difference.

	Flexible endoscope		Rigid endoscope		Total			
	N	%	N	%	N	%	χ^2	p
1) Stereoscopic representation of organs and tissues as well as stereoscopic sense of movements							35.813	<0.001
Poor	57	6.8%	10	6.2%	67	6.7%		
Average	352	42.3%	67	41.4%	419	42.1%		
Good	417	50.1%	72	44.4%	489	49.1%		
Very good	7	0.8%	13	8.0%	20	2.0%		
2) Stereoscopic sense of instrument and suture needle							43.143	<0.001
Poor	57	6.8%	7	4.3%	64	6.4%		
Average	355	42.6%	76	46.9%	431	43.3%		
Good	419	50.3%	69	42.6%	488	49.0%		
Very good	2	0.2%	10	6.2%	12	1.2%		
3) Viewing 3D images allows directly grasping and cutting tissues								
Poor			4	2.5%	4	2.5%		
Average			71	43.8%	71	43.8%		
Good			79	48.8%	79	48.8%		
Very good			8	4.9%	8	4.9%		

Table 4 Analysis of comprehensive statistical data on stereoscopic comfort and fluency scores

Conclusions

Lee et al. [1] investigated the oncology and technical advantages of 3D and 2D laparoscopy in gastric cancer surgery and found that the total operation time with 3D laparoscopy was significantly less than that with 2D. The 3D MonoStereo® system may reduce technical errors and shorten operation time. It can also be used with various 2D endoscope brands, thus reducing the equipment cost.

According to Agrusa et al. [2], the operation time with the use of the 3D vision system was relatively short; however, it could cause headache and dizziness. The levels of stereoscopic depth of field effect can improve the dizziness and nausea symptoms of doctors.

References

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