

Cost-Minimization Analysis of Robotic Versus Laparoscopic-Assisted Liver Cancer Resection

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Abstract

Background: In the treatment of patients with liver cancer, laparoscopic liver cancer resection is the earliest and most widely used minimally invasive surgery. Robotic surgery technology helps surgeons overcome the shortcomings of traditional laparoscopic surgery by providing surgeons with high-resolution 3D images, wrist instruments that provide degrees of freedom, and tremor filtering technology.

Objective: We designed a cost-minimization analysis to explore the cost difference of robot-assisted versus laparoscopic-assisted liver cancer resection, so as to provide the valuable reference for clinical practice and patients.

Results: A total of 51 patients performed with liver cancer were carefully chosen from Gansu Provincial People's Hospital, which included eighteen patients with robot-assisted hepatectomy and thirty-three patients with laparoscopic-assisted hepatectomy.

The Cost-minimization analysis showed that the average medical cost per patient receiving robotic surgery was 60,322 yuan, and the average medical cost per patient receiving laparoscopic surgery was 46,867 yuan. Compared with robotic surgery, laparoscopic surgery could save 13,455 yuan.

Method: Cost-minimization analysis was designed to determine the best option economic for medical technology with the similarity of efficacy and safety for robotic hepatectomy and laparoscopic hepatectomy. Excel 2016 software was used to collect and analyze cost data. Oneway deterministic sensitivity analysis was performed to assess the uncertainty of the parameter (cost of operation, cost of medical materials, cost of adjuvant therapy, cost of medicine, cost of medical examination, cost of anesthesia, cost of health care, and cost of hospitalization) values and gauge the reliability and generalizability of the results.

Manuscript Information: Received: Aug 21, 2023; Accepted: Jan 03, 2024; Published: Jan 10, 2024

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Citation: Aboudou T, Li M, Li Y, Idris Abdu H, Yang K, et al. Cost-Minimization Analysis of Robotic Versus Laparoscopic-Assisted Liver Cancer Resection. *J Surgery*. 2024; 4(1): 1140.

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Conclusion: The comparison between robotic-assisted liver surgery and laparoscopic surgery shows that the average medical cost was higher in robotic surgery when compared to laparoscopic liver cancer.

Keywords: Cost-minimization; Robotic; Laparoscopic-assisted; Liver; Cancer.

Introduction

Hepatocellular Carcinoma (HCC) was rated as the sixth cancer in the world [1,2], it has a high mortality rate [3-5]. The pathogenesis of HCC is mainly related to HBV or HCV infection. Hepatectomy is a surgical procedure that removes local lesions from the liver to retain a normal function of the liver group, mainly for the treatment of liver cancer and some benign liver diseases (such as hepatic angiosarcoma, hepatic dysplastic nodules, hepatic leiomyoma) [4,6,7]. In the treatment of patients with liver cancer, laparoscopic liver cancer resection is the earliest and most widely used minimally invasive surgery [8,9]. However, it also has limitations such as two-dimensional surgical field, limited movement of laparoscopic instruments, and inevitable physiological tremors [3,10-12]. Robotic surgery technology helps surgeons overcome the shortcomings of traditional laparoscopic surgery by providing surgeons with high-resolution 3D images, wrist instruments that provide degrees of freedom, and tremor filtering technology [13]. However, studies [14-16] found no significant difference between the robotic surgery group and the laparoscopic group in terms of transfusion rate, conversion rate, estimated blood loss, length of hospital stay, and reoperation rate. In this case, which with lower costs may be the best option. Cost-minimization identifies the lowest cost of treatments that have been shown to be otherwise equivalent in clinical effectiveness.

Therefore, we designed a cost-minimization analysis to explore the cost difference of robotic-assisted versus laparoscopic-assisted liver cancer resection, so as to provide the valuable reference for clinical practice and patients.

Methods

Study design: Cost-minimization analysis was designed to determine the most economical option for the medical technology with the same efficacy and safety. Since the efficacy and safety of robotic-assisted and laparoscopic liver cancer resection are comparable, this study aims to compare the costs of the two surgical methods. The costs in economic evaluation include direct costs, indirect costs and hidden costs. This study only compares the direct medical costs, including operation fee, medical materials fee, adjuvant therapy fee, medicine fee, medical examination fee, anesthesia fee, health care fee, and hospitalization fee. All costs are in 2022 RMB.

Data source

The purpose of this study is to reflect the situation in the real world. We investigated liver cancer patients from Gansu Provincial People's Hospital, including adult patients with robot assisted liver cancer resection and patients with laparoscopic assisted liver cancer resection.

Statistical analyses

This study uses excel 2016 software to collect and analyze cost data. The analysis outcomes include the total costs of per patient

undergoing robotic surgery and laparoscopic surgery, and the average costs of per patient in each cost item, including operation fee, medical materials fee, adjuvant therapy fee, medicine fee, medical examination fee, anesthesia fee, health care fee, and hospitalization fee.

One-way deterministic sensitivity analysis was performed to assess the uncertainty of the parameter values and gauge the reliability and generalizability of the results. The parameters included: cost of operation, cost of medical materials, cost of adjuvant therapy, cost of medicine, cost of medical examination, cost of anesthesia, cost of health care, and cost of hospitalization.

All parameters were subjected to $\pm 10\%$, and assuming they were all independent of each other.

Results

Fifty-one patients with liver cancer were selected from Gansu Provincial People's Hospital, including 18 patients with robot assisted hepatectomy and 33 patients with laparoscopic assisted hepatectomy. The Cost-minimization analysis showed that the average medical cost of per patient receiving robotic surgery was 60,322 yuan, and the average medical cost of per patient receiving laparoscopic surgery was 46,867 yuan. Compared with robotic surgery, laparoscopic surgery could save 13,455 yuan. The operation fee, medical materials fee, other adjuvant therapy fee and health care fee of robotic surgery are higher than those of laparoscopic surgery. However, the medicine fee, medical examination fee, anesthesia fee and hospitalization fee of laparoscopic surgery are slightly higher than those of robotic surgery. Among them, the biggest difference is the operation fee, which is 16,915 yuan for robotic surgery and 6467 yuan for laparoscopic surgery, the difference is 10,448 yuan. See Table 1 and Figure 1.

Table 1: Clinicopathological characteristics of PEACs in comparison with MCC.

Cost item	Robotic hepatectomy (¥)	Laparoscopic hepatectomy (¥)	Cost (¥)	Saving Proportion of cost saving (%)
Operation	16,915	6467	10,448	78%
Medical materials	13,524	11,842	1682	13%
Adjuvant therapy	9796	4959	4837	36%
Medicine	9244	10,718	-1474	-11%
Medical examination	7416	9090	-1674	-12%
Anesthesia	2046	2274	-228	-2%
Health care	842	802	40	0%
Hospitalization	539	715	-176	-1%
Total cost	60,322	46,867	13,455	100%

Cost item	Robotic hepatectomy (¥)	Laparoscopic hepatectomy (¥)	Proportion of cost saving (%)
Operation	16915	6467	78%
Medical materials	13524	11842	13%
Adjuvant therapy	9796	4959	36%
Medicine	9244	10718	-11%
Medical examination	7416	9090	-12%
Anesthesia	2046	2274	-2%
Health care	842	802	0%
Hospitalization	539	715	-1%

Figure 1: Costs difference of robotic assisted versus laparoscopic hepatectomy.

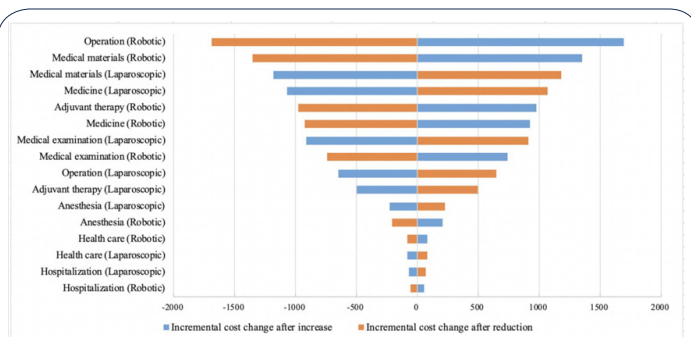


Figure 2: Tornado diagram depicting the results of one-way sensitivity analyses.

Sensitivity analyses showed cost of robotic-assisted operation and medical materials had a significant impact on the results (Figure 2).

Discussion

Since the introduction of the robotic surgery, there has been a push to demonstrate the effectiveness and safety of robotic-assisted over the conventional laparoscopic liver cancer resection [17-19]. The Cost-minimization analysis showed that the average medical cost of per patient receiving robotic surgery was higher than receiving laparoscopic liver cancer resection. Compared with robotic surgery, laparoscopic surgery could save 13,455 yuan. The biggest difference is the operation fee, which is 16,915 yuan for robotic surgery and 6467 yuan for laparoscopic surgery, the difference is 10,448 yuan.

Although this study indicated that robot-assisted liver cancer resection maybe more expensive than laparoscopic liver cancer resection, clinical clinicians and patients should consider more factors when deciding whether to choose robotic assisted liver cancer resection. Currently, an increasing number of studies have investigated the clinical outcomes of robot-assisted liver cancer resection versus laparoscopic and open liver cancer resection, however, the evidence of cost analyses was lacking, and the results of the limited evidence was inconsistent. Wu et al analyzed 100 patients and indicated that the robotic group incurred higher peri-operative expenses, while the cost of inpatient care was lower than open surgery group [7]. One study from USA indicated that the operative cost was significantly higher in the robotic group, while overall admission cost was comparable between robotic and conventional open hepatectomy [20]. A meta-analysis including 29 studies (537 patients) indicated that the cost of the laparoscopic liver cancer resection was greater than robotic surgery, the results was conflict with our results, it should be interpreted with caution. Therefore, more research are needed to further analyze

the costs of robot-assisted, laparoscopic, and open liver cancer resection in the future.

Due to a number of technological advancements, including greater visibility, increased angulation and range of motion, and more precise suturing, robotic surgical systems are better than laparoscopic devices [20-24]. Robotic surgical systems are now employed in a wide range of operations and specialties, such as head and neck surgery, urology, endocrine surgery, metabolic and bariatric surgery, and all intra-abdominal surgery subspecialties [25-27]. Additionally, the number of patients undergoing robotic surgery is rising quickly. Because of limited evidence of the efficacy, safety, and economic evaluation of robotic assisted liver cancer resection versus laparoscopic liver cancer resection, in the future, more high-quality studies are needed to further explore the advantages and disadvantages of robot-assisted liver cancer resection versus laparoscopic liver cancer resection.

Limitations

There are several limitations of this study. On the one hand, our data source are limited and only from one single hospital in Lanzhou of China, a broader range of evidence is needed to support clinical practice in the future; On the other hand, this study assumed that the efficacy of robot assisted liver cancer resection and laparoscopic liver cancer resection were consistent, but the efficacy and safety outcomes we analyzed were limited, some long-term outcomes, such as overall survival, and incidence of adverse events, were not analyzed. Therefore, future studies in this area are needed.

Conclusion

Limited data showed that the average medical cost of robotic-assisted liver cancer resection was higher than laparoscopic liver cancer resection. The difference is mainly due to the operation fee. To further analyze the advantages and disadvantages of robotic-assisted and laparoscopic liver cancer resection, high-quality cost-effectiveness analysis is needed in the future.

Declarations

The authors declare no conflicts of interest.

No funding was received for writing this manuscript.

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