Effectiveness, Safety and Economic Evaluation of Using Varied-Height Surgical Staplers in Laparoscopic Hepatectomy for Liver Cancer: A Retrospective, Real-World Study

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Feel free to contact us for any questions via email at 19921258959@163.com

Jing Li[1], Yan-Qing Jiang[2], Peng Liu[3], Zi-Xiao Hao[3], Jian-Wei Xuan[1]

[1] Health Economic Research Institute, School of Pharmacy, Sun Yat-sen University, Guangzhou, China, [2] School of Pharmaceutical Sciences, Southern Medical University, Guangzhou, China, [3] Medtronic, Inc, Shanghai, China

Background

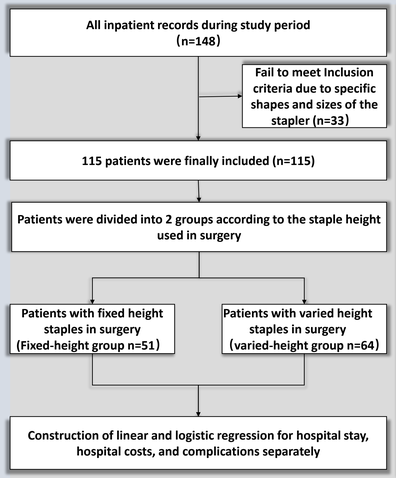
- A report about global cancer statistics shows that there were an estimated 905,677 new liver neoplasms patients and 830,180 liver neoplasm deaths around the world during 2020, of which approximately 46% of the total new cases and deaths were in China.
- With improved knowledge of liver anatomy, better understanding of the underlying causes of liver tumors and improvements in surgical techniques, laparoscopic hepatectomy has been extensively applied to both benign and malignant liver lesions.
- Depending on variation in tissue thickness, reloads with stepped staple heights may be necessary for laparoscopic hepatectomy, which is crucial for a complication-free recovery, minimized pain and discomfort as well as a short hospital stay.

Objective

The objective of this study is to compare clinical and economic outcomes of varied-height staple versus fixed-height staple for laparoscopic liver resection surgery.

Methods

- Data of patients who underwent hepatectomies between April 1st, 2014 to December 31st, 2020 were collected from the Department of Liver Surgery of a Grade-A tertiary hospital in Chongqing.
- Patient demographics, clinical manifestation, type of resection performed, intraoperative data, short-term outcomes and treatment cost data were collected.
- Categorical variables were exhibited as n (%) and continuous variables were expressed as mean ± SD values for data with a normal distribution, and as median (interquartile range) values for data with a non-parametric distribution.
- Linear and Logistic regression models are used to find and identify patterns and relationships between variables from complex data sets, identify risk factors, and provide a coefficient of the influence of a factor on the outcome variable.



Inclusion criteria

(1) Patients with liver tumours
(2)18–75 years old
(3) Child-Pugh classification A /B
(4) Three-row linear stapler

Exclusion criteria

(1)Emergency surgery was performed due to critical condition
(2)Accepted radiotherapy and chemotherapy targeted immunotherapy three months prior to the surgery
(3) Surgery was switched to open surgery
(4) Mixed use of staplers of varied height and single height
(5) Missing clinical data

Fig. 1 Flowchart of the patient inclusion

Results

- 115 patients were included in the study, of which 55.65% used varied-height staplers during surgery and 44.35% by fixed-height staplers. Baseline characteristics of the study group are summarized in Table 1.
- The overall medical costs were similar in the two groups (71,603 versus 72,066 RMB respectively; P = 0.5734). Median hospital stay was 15.0 (range 13.0–18.0) days for varied-height cartridge group and 15.0 (13.0–19.0) days for the fixed-height cartridge group (P = 0.3827). Rate of performing a hepatic portal occlusion in varied-height group was significantly lower than that in the fixed-height group (p=0.026). No death occurred in the two groups during the perioperative period. (Table 2)
- The multiple logistic regression analyses revealed that patients who used fixed-height staplers were significantly more likely to experience complications compared to those who used varied-height staplers (OR: 0.34 (0.14–0.83), p = 0.02). Besides, according to expert opinions in clinical practices, if satellite nodules were distant from the main liver tumor, laparoscopic hepatectomy would not be performed, which resulted in a low OR value. (Table 3)

Table 1 Baseline patient characteristics in the varied-height group and fixed-height group

Variables	Varied-height group (n=64)	Fixed-height group (n=51)	P value
Age, Mean ± SD, years	51.22 ± 11.94	50.88 ± 12.86	0.8849
BMI, Mean ± SD, kg/m²	23.11 ± 3.43	23.03 ± 3.40	0.8997
Sex			0.4780
Male	50 (78.13%)	43 (84.31%)	
Female	14 (21.88%)	8 (15.69%)	
Liver cirrhosis	52 (81.25%)	39 (76.47%)	0.5310
Child–Pugh grade			1.0000
A	51 (98.08%)	38 (97.44%)	
B	1 (1.92%)	1 (2.56%)	
HBsAg			0.2760
Negative	11 (17.19%)	13 (25.49%)	
Positive	53 (82.81%)	38 (74.51%)	
Previous surgery			
Liver resection	1 (1.56%)	0 (0%)	1.0000
Abdominal surgery	15 (23.44%)	11 (21.57%)	0.8120
Co-morbidity			
PVTT	3 (4.69%)	0 (0%)	0.3281
HVTT	1 (1.56%)	1 (1.96%)	1.0000
Recurrent liver cancer	3 (4.69%)	1 (1.96%)	0.7790
Hepatitis	54 (84.38%)	41 (80.39%)	0.5760
Hypertension	9 (14.06%)	2 (3.92%)	0.1291
Diabetes	3 (4.69%)	6 (11.76%)	0.2917
Emphysema	1 (1.56%)	3 (5.88%)	0.4570
Number of tumors			0.6915
Single	59 (92.19%)	45 (88.24%)	
Multiple	5 (7.81%)	6 (11.76%)	
Number of tumors (IQR)	1 (1,1)	1 (1,1)	0.4629
Maximal diameter of tumor, cm (IQR)	3.9 (2.5,6)	3.5 (3,6.5)	0.4052
Degree of tumor differentiation			0.8120
High	5 (8.47%)	2 (4.44%)	
Medium	46 (77.97%)	37 (82.22%)	
Low	8 (13.56%)	6 (13.33%)	
Tumor classification			0.1300
HCC	56 (87.50%)	39 (76.47%)	
IHCC	2 (3.13%)	7 (13.73%)	
Mixed cell hepatoma	1 (1.56%)	0 (0%)	
Neuroendocrine carcinoma	1 (1.56%)	0 (0%)	
Others	4 (6.25%)	5 (9.80%)	
Microvascular invasion(MVI)			0.6100
Not found	44 (68.75%)	39 (76.47%)	
Low risk	16 (25%)	9 (17.65%)	
High risk	4 (6.25%)	3 (5.88%)	
Satellite nodules	1 (1.56%)	5 (9.8%)	0.1206
Type of resection performed			p<0.05
Anatomical liver resection	48 (75%)	29 (56.86%)	
Non-anatomic liver resection	16 (25%)	22 (43.14%)	
Mixed cholecystectdmy	20(31.25%)	19 (37.25%)	0.4990
Number of staplers (sets)	2(1,2)	2(1,2)	0.0949

Table 2 Outcomes between varied-height and fixed-height groups

Variables	Varied-height group (n=64)	Fixed-height group (n=51)	P value
Total medical cost	71603(67141,83659)	72066(64586,79783)	0.5734
Length of hospital stay, days	15.0 (13.0,18.0)	15.0(13.0,19.0)	0.3827
Duration of ICU stay, days	0.6 (0.5,0.8)	0.7 (0.5,0.8)	0.9050
Operation time, min	225.5 (159.0,304.0)	240.0 (153.0,292.0)	0.7165
Intraoperative bleeding	64 (100%)	51 (100%)	-
Intraoperative blood loss, ml	200 (200,400)	200 (150,400)	0.5143
Intraoperative blood transfusions	4 (6.25%)	5 (9.80%)	0.7222
Hepatic portal occlusion	32 (50%)	36 (70.59%)	p<0.05
Number of hepatic portal occlusion	3 (2,4.5)	3 (2,5.5)	0.8657
Hepatic portal occlusion duration, min	40 (28.5,60)	42.5 (28.5,70)	0.4297
Removal time of drain after surgery, days	5 (4,7)	6 (5,7)	0.3254
Postoperative bleeding	0 (0%)	2 (3.92%)	0.1950
Postoperative blood transfusion	5 (7.81%)	8 (15.69%)	0.1850
Secondary operation	3 (4.69%)	4 (7.84%)	0.7561
Surgical site infection	4 (6.25%)	1 (1.96%)	0.5091
Inflammation of other sites	4 (6.25%)	4 (7.84%)	0.9719
Post-operative complications	31 (48.44%)	33 (64.71%)	0.0810
Grade I	31 (48.44%)	33 (64.71%)	0.0810
Grade II	0 (0%)	2 (3.92%)	0.1950
Grade IIIa	3 (4.69%)	4 (7.84%)	0.7561

Table 3 Multiple stepwise logistic regression analysis of factors related to complications

Variables	Odds ratio	Std. err.	z	P>|t|	[95% CI]	
Varied-height staplers	0.34	0.16	-2.36	0.0180	0.14	0.83
Non-anatomic resection	1.77	0.87	1.16	0.2480	0.67	4.63
Age	0.97	0.02	-1.77	0.0770	0.93	1.00
Microvascular invasion(MVI)	2.14	1.08	1.51	0.1300	0.80	5.75
Satellite nodules	0.05	0.07	-2.33	0.0200	0.00	0.63
Prior abdominal surgery	0.44	0.24	-1.52	0.1290	0.15	1.27
_cons	11.70	12.47	2.31	0.0210	1.45	94.54

Conclusions

The use of staplers with varied-height has the advantages of decreasing the probability of postoperative complication after liver resection with no significant cost difference. The surgical technology is therefore recommended for patients with liver cancer in laparoscopic hepatectomy.