Original Article

Outcome and Complications of Crush Clamp and Ultrasonic Dissection Techniques in Hepatectomy of Patients With Hepatic Mass

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ABSTRACT

Objectives: Perioperative hemorrhage and postoperative bile leakage are important complications of hepatectomy. Various methods have been reported to reduce intra-operative bleeding during liver transection. We designed a randomized clinical trial to compare the outcomes and complications between Crush Clamp (CC) and ultrasound dissection methods (the Cavitron Ultrasonic Surgical Aspirator, CUSA) in liver transection.

Methods: Twenty patients underwent hepatectomy with the crush clamp method, and 20 underwent ultrasonic dissection. The surgical outcome and complications, including duration of the surgery, bleeding, packed cells requirement after the operation, bile leakage, hospital stay, and hepatic failure, were evaluated and compared.

Results: Mean blood loss during the operation in the CUSA group was less than CC group, but this loss was not significant (247±77.1 in CC vs 232.2±84.3 mL in CUSA, P=0.769). The operation time in the CC group was longer than in the CUSA group, but this difference was not significant (171.3±55.1 min in CC vs 163.1±74.2 min in CUSA; P=0.72). The duration of transection in patients of the CC group was significantly less than that in the CUSA group (47.5±21.1 min for CC vs 77.6±30.4 min for CUSA, P=0.06), and the length of hospitalization in the CC group was significantly less than CUSA group (1.9±0.7 day for CC vs 2.8±1.1 day for CUSA, P=0.016). There were no cases of infection and bile leakage in the two groups.

Discussion: Postoperative complications did not differ in the two groups, but the duration of transection in crush clamp was shorter than the ultrasonic dissection method, and blood loss was almost identical. Because ultrasonic dissection is an equipment-dependent procedure and more expensive, we tend to perform liver transection with the crush clamp method.

Keywords: Hepatectomy, Crush clamp method, Ultrasonic dissection, Hepatic mass, Hepatobiliary surgery

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1. Background

In patients with different liver masses (metastases, primary malignant or benign tumors), partial resection of the liver is possible because the liver is a tissue with regenerative properties. Therefore, hepatectomy is a treatment for many liver lesions. However, the surgery of this vital organ is one of the major surgeries due to its complex, vascular, and unique anatomy with double blood supply. Hepatectomy can be an anatomical resection or not in the anatomical range.

Hepatectomy is more difficult due to its vascular and hemorrhagic tissue, so the correct resection technique is of great importance and priority [1-5]. Various techniques have been proposed for hepatectomy with minimal tissue damage and bleeding, from the old finger fracture technique to the new technology-related techniques such as ultrasound nife (CUSA nife) [6].

Two methods are widely used today in many centers: the traditional Crush Clamp (CC) method and the technology-dependent method that uses an ultrasonic device to dissect the liver tissue, known as a Cavitron Ultrasonic Surgical Aspirator (CUSA). However, practical hepatectomy is associated with risks of morbidity and mortality due to bleeding during and after surgery. It is an important complication of these surgical techniques.

The CC technique has been used since the early 20th century to prevent bleeding when the parenchyma is resected. It is still used as a method of choice in many hepatobiliary centers. Proponents of this technique mention high speed as an advantage of this method. However, opponents say bleeding and tissue damage are more likely to occur. Obstruction of blood flow can impair hepatic ischemia-reperfusion, especially in patients with reduced hepatic reserve [7]. In recent years, various new techniques, including CUSA, have been used. It was developed for liver parenchymal transection and has been used for hepatectomy. Although CUSA is more time-consuming, it may reduce tissue damage and complications, such as bleeding and bile leakage. However, this advantage has not yet been fully and accurately proven, and there is controversies [8].

Koo et al. reported that hepatectomy with CUSA increases the risk of thromboembolism [9]. In a clinical trial, Lupo et al. compared hepatectomy with Radiofrequency (RF) ablation and CC and reported no difference in mortality between the two groups, but in patients with hepatic RF resection, gallstones and internal abscesses were more frequent. Also, the CC procedure was associated with more bleeding [10]. In another study published by Appere et al., hepatectomy was compared between two Ultracision Harmonic Scalpel (UHS) and ultrasonic (CUSA) methods. The duration of surgery on the UHS was significantly shorter, but its complications and mortality were no different from the CUSA method; it seems to be a safe and effective method in hepatectomy [11]. In this study, we compared CC and CUSA techniques in terms of outcomes, complications, morbidity, length of hospitalization, bleeding, and mortality in patients with liver mass who underwent hepatectomy.

2. Materials and Methods

The present study was a clinical trial performed from September 2016 to the end of March 2017 in Golestan Hospital in Ahvaz City, Iran, to compare the outcomes of CUSA and CC techniques of hepatectomy. In this study, 40 patients who underwent hepatectomy for various reasons were randomly divided into two groups.

Since the type of tumor and the type of hepatectomy affect the complications and outcomes, we tried to match the two groups in terms of tumor type and type of hepatectomy. After selecting the type of techniques of hepatectomy, from the beginning of the operation, all variables, including operation time, hepatectomy time, amount of bleeding, ABG changes during and after surgery, urine output during and after surgery, liver function tests of the patient in days 2, 3, and 5 after the operation, and the patient's INR (International Normalized Ratio) was recorded and compared at 1, 2, 3, and 4 days of post-operation. The amount of drainage in patients was also calculated. All patients underwent abdominopelvic sonography on the 3rd and 30th day of post-operation for the survey of the abdominal abscess. Patients were re-evaluated one month after discharge. Finally, the collected data were analyzed by SPSS software version 22. We used the t test to compare the mean of quantitative data between the two groups, the Chi-square test was used to compare qualitative data, and a $P<0.05$ was considered statistically significant.

3. Results

The results of our study showed that gender distribution (male/female) in the CC group was 7 (35%)/13 (65%), and in the CUSA group, 5 (25%)/15 (75%). The two groups did not have a significant difference (P=0.482) in this regard (Table 1).

The results showed that the Mean±SD age of the patients in the CC group was 53.5±11.6 years, and in the CUSA group, 49.6±15.4 years. The two groups were almost in the same age range, and there was no significant difference between them in this issue (P=0.62). Furthermore, the operation time in the CC group was longer than in the CUSA group, but this difference was not significant (P=0.72). On the other hand, the duration of transection (P=0.006) and the length of hospitalization after surgery (P=0.016) were significantly longer in the ultrasonic dissection technique (Table 1).

In addition, the amount of bleeding during the operation in the CUSA group was less than CC group, but this difference was not significant (P=0.769). Also, there was no significant difference between the two groups in the number of Packed RBC Cell (PC) received (P=0.438) (Table 2). A comparison of liver function tests showed that on the first and second day after surgery, neither of the groups showed significant differences (P<0.05) (Table 2). Furthermore, gallstones and infections were not seen in any patients studied. However, abdominal ascites was seen in only one patient in the CUSA group on the 30th day after surgery.

In terms of liver failure, there were two cases. In the CUSA group, there was a 3-year-old boy. He was a known case of hepatoblastoma with ascites and liver failure and expired after two weeks. Another case was a 27-year-old woman with hemangioma in the CC group, who developed acidosis and impaired liver enzymes and increased International Normalized Ratio (INR) after a week of medical treatment; his failure was improved, fortunately.

4. Discussion

In this study, we compared CC and CUSA techniques in terms of outcomes and complications in patients with liver mass who underwent hepatectomy and the results showed that the operation time in the CC group was longer than CUSA group, but this difference was not significant (P=0.72). On the other hand, the duration of transection (P=0.006) and the length of hospitalization after surgery (P=0.016) were significantly higher in the ultrasonic dissection technique. Mean blood loss during the operation in the CUSA group was less than CC group, but this extra loss was not significant (P=0.769). In the following, we compare our results with other studies.

Surgical hepatectomy has been developed recently and is still the mainstay of treatment for benign and malignant liver tumors [5]. This procedure has significant complications associated with several variables such as the surgeon's skill, anesthesia, preoperative evaluation and preparation, follow-up, and postoperative management. Minimizing bleeding is very important in hepatectomy, and surgeons have worked hard to achieve this goal. Numerous reports have shown the usefulness of energy devices that should be used in liver resection [12-18]. On the other hand, studies showing no difference with older techniques, including a study by Clark et al. They compared CUSA with an endoscopic stapler and reported no significant differences in the amount of bleeding, transection time, and operation time between these two groups [15].

Several studies showed that CUSA has no special advantages over CC. In contrast, the risk of thromboembolism is greater with CC [19]. Furthermore, there is generally no agreement on using energy devices to minimize bleeding during hepatectomy.

In our study, the operation time in the CUSA technique was shorter than that in the CC, but this difference was not significant. Furthermore, according to our results, the duration of hepatectomy and the length of hospitalization after surgery by the CUSA technique were significantly higher. According to Xiao et al., the duration of hepatectomy in CUSA was longer but not significant [20]. Furthermore, Koo et al. reported that although in the CUSA group, the duration of operation time was somewhat shorter, the duration of transection time was longer than in the CC group.

In the present study, the amount of bleeding during the operation in the CUSA group was less but was not significant. In concordance with our finding, in Hodgson and Morgan18 study, there was more bleeding in CUSA, which was not significant. Of course, they have reported fewer complications with the CC technique. Based on that, they reported CC as a better quality technique.

In a meta-analysis study, no difference was found between these two groups regarding the bleeding rates [21]. In contrast, in a study by Sherman et al., there was more bleeding with the CC technique [22].

In contrast to our study, previous studies have reported an increased risk of abdominal abscesses in CUSA technique [23-30]. None of our participated patients developed an abdominal abscess. Examining other complications, we found that the number of packed cells received during the operation and the changes in the liver markers did not differ significantly between the two groups after the operation. The postoperative complications in the

Table 1. Demographic characteristics of the studied patients

Demographic Characteristics		Mean±SD / No. (%)		P
		Clash Clamp	CUSA	
Gender	Male	13(65)	15(75)	0.48
	Female	7(35)	5(25)	
Age, y		53.5±11.6	49.6±15.4	0.62
Surgery time, min		171.3±55.1	163.1±74.2	0.72
Transection time, min		47.5±21.1	77.6±30.4	0.006
Hospitalization time, d		1.9±0.7	2.8±1.1	0.016

Judishapur Journal of Oncology (JJO)

CUSA: the Cavitron Ultrasonic Surgical Aspirator.

CUSA and CC groups did not differ significantly. These results demonstrate that the CC technique has comparable outcomes. On the other hand, since the CUSA technique is equipment-dependent and is more expensive to run, we recommend the CC as a more appropriate technique in our settings in hepatectomy.

5. Conclusion

The time of operation and bleeding during the operation in the CUSA group was somewhat less, and the duration of the transection in the CC was significantly less. Despite those, no other differences were observed between the two groups regarding other surgical complications. However, the CUSA method depends on the availability of expensive equipment and imposes high costs on the healthcare system, so the CC method seems to be a more appropriate choice. This preferred method is also very cheap and has a low risk of complications.

Ethical Considerations

Compliance with ethical guidelines

Table 2. Clinical outcomes and changes in laboratory parameters among patient's undergone liver transections By CC and CUAS techniques

Clinical Statistics	Days	Mean±SD		P
		Crash Clamp	CUSA	
Intraoperative bleeding, mL	-	247±77.1	232.2±84.3	0.769
Packed Cells received during surgery, mL	-	0.81±0.3	0.95±0.4	0.438
AST, IU/L	First	244.5±110.4	215.1±104.2	0.57
	Second	191.3±28.5	184.1±49.3	0.31
ALK, IU/L	First	233.3±95.1	248.1±98.4	0.33
	Second	154.2±25.4	193.5±24.3	0.41
ALT, IU/L	First	261.5±63.1	216.1±53.4	0.34
	Second	133.7±65.8	148.2±53.5	0.12
Bili-T, mg/dl	First	2±0.8	1.7±0.8	0.67
	Second	1.7±0.5	1.6±0.6	
Bili-D, mg/dl	First	1±0.5	1.2±0.5	0.83
INR	First	1.12±0.13	1.41±0.5	0.11
	Second	1.08±0.7	1.35±0.6	0.31

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CUSA: Cavitron Ultrasonic Surgical Aspirator; CC: Crash Clamp; AST: Aspartate Transaminase; ALT: Alanine Transaminase; Bil-T: Bilirubin Total; Bil-D: Blirubin Direct; INR: International Normalized Ratio.

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Authors' contributions

All authors equally contributed to this project and article.

Conflict of interest

The authors declare no conflict of interest.

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