# Liver Transection Technique in Living Donor Liver Transplantation, A Comparative Study at King Hussien Medical Center- Jordan

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## ABSTRACT

**Objectives:** The aim of this study is to compare clamp crushing technique to Cavitron ultrasonic surgical aspirator for parenchymal transection in terms of efficacy and safety in living donor liver transplantation.

**Methods:** This retrospective study has been conducted to compare Cavitron Ultrasonic Surgical Aspirator and clamp crushing technique. During the period from July 2004 to September 2013, a total of 90 donors underwent liver resection for living donor liver transplantation using clamp crush technique or Cavitron Ultrasonic Surgical Aspirator were included in this study. A total of 90 hepatectomies have been done (77 right hepatectomy، 10 left hepatectomy and 3 Left lateral segmentectomy).Data of both groups in term of intraoperative blood loss, need for blood transfusion, transection time, hospital stay, postoperative morbidity and mortality were analyzed.Cavitron Ultrasonic Surgical Aspirator with standard tip was used for parenchymal transection. The primary endpoints were blood loss during parenchymal transection and resection time. Secondary end points were the need for blood transfusion, the degree of postoperative hepatocyte injury, postoperative complication, Intensive care unit stay and hospital stay. The liver resection time defined as the duration from the beginning of parenchymal transection until the completion of transection with complete achievement of hemostasis from the liver cut surface. The remaining liver was assessed daily until hospital discharge, the assessment parameters include: bilirubin level, alanine aminotransferase , aspartate aminotransferase level and Partial thromboplastin time.

**Results:** A total number of 90 patient's records were analyzed in this retrospective study. Clamp crushing technique was used in 48 donors (group A); while Cavitron ultrasonic surgical aspirator was used in 42 donors (group B). Mean blood loss was significantly lower in the clamp crushing technique group (310 ml) than the Cavitron ultrasonic surgical aspirator group (345ml) (P value 0.0092). Transection time was shorter in the clamp crush group but not statically significant. There were no significant differences between both groups in term of postoperative hepatocyte injury indicated by (aspartate aminotransferase and alanine aminotransferase levels), bilirubin and International randomized ratio . There was no significant difference in the Intensive care unit and hospital stay in both groups.

No significant difference was found in the postoperative complications between both groups. 7 patient's developed superficial wound infection,4 in group A and 3 in group B. Atelectasis or pleural effusion occur in 11 patients, 6 in group A and 5 in group B. 1 patient in group A developed pneumonia. Biloma occurred in 3 cases, one in group A and 2 in group B. Incisional hernia occurred in 2 patients one in each group. There was no mortality in both groups.

**Conclusion:** Clamp-crush technique has been associated with less blood loss in comparison to Cavitron ultrasonic surgical aspirator. However, there were no significant differences between the two groups regarding morbidity and mortality.

**Key Words:** Cusa, Liver, Living donor, Liver transection, Transplantation.

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## Introduction

The shortage of cadaveric organs worldwide made living donor liver transplantation (LDLT) to become an acceptable alternative for patients requiring liver transplantation (LT), especially those patients who are not likely to receive a cadaveric liver because of the long waiting list.

Liver resection for living donor liver transplantation has been increased markedly over the last 2 decades

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due to the shortage of cadaveric organs, mainly in countries where cadaveric donation is restricted by cultural and religious believes, also, improved postoperative outcomes, and the evidence that this procedure may be the only hope for patients to be cured from their illness increased the popularity of the procedure.

With the increased cases of LVDT, several technical innovations in liver transection have been developed. However, regardless of which device is used (such as CUSA, Water Jet Dissector, Monopolar and Bipolar Coagulator), the goal of parenchymal transection is to limit blood loss as little as possible, and thus decreases blood transfusion and at the same time respecting the anatomical structures vital to the graft and to the donor.

The aim of this study is to compare clamp crushing technique to Cavitron ultrasonic surgical aspirator (CUSA) for parenchymal transection in terms of efficacy and safety in LDLT.

## Methods

During the period from July 2004 to September 2013, a total number of 90 donors underwent liver resection for living donor liver transplantation using clamp crush technique or CUSA (53 male and 37 female with mean age of 36 years) included in the study.).Data of both groups in terms of intraoperative blood loss, need of blood transfusion, transection time, hospital stay, postoperative morbidity and mortality were analyzed.

Cavitron Ultrasonic Surgical Aspirator (CUSA) with standard tip was used for parenchymal transection with the following sittings ; 23 kHz , 70 Watt, and continuous irrigation at rate of 4-6 ml/min with normal saline.

The Pringle maneuver is an intraoperative maneuver used in liver surgeries. Atraumatic clamp is used to clamp the hepatoduodenal ligament which interrupt blood inflow to the liver and thus helping to control bleeding from the liver.

Pringle's maneuver has been applied only when significant bleeding occurred and prevented selective coagulation or ligation of small vessels or when blood loss was more than 500 mL which occurred only in one case during the transection with CUSA.

All patients were operated by the same surgical team and supervised by single senior surgeon.

All liver resections were performed with the low central venous pressure (CVP) (0–5 mm Hg). All patients underwent an intra-operative ultrasound and per-operative cholangiogram to define the major biliary system anatomy and vasculature.

The primary endpoints were Blood loss during parenchymal transection and resection time. Secondary end points were the need for blood transfusion, the degree of postoperative hepatocyte injury, postoperative complication, ICU and hospital stay periods.

Blood loss prior to the transection was not included and only the blood loss during parenchymal transection, and immediately after hepatectomy until completion of the procedures were included. The volume of blood loss during transection and post-transection until hemostasis achieved was estimated by the volume of blood suctioned and subtraction of rinse fluids and the swabs Weight that were used during transection (each mL of blood assumed to equal 1 g) from the measured volume.

The liver resection time is defined as the duration from the beginning of parenchymal transection until the completion of transection with complete achievement of hemostasis from the liver cut surface.

The mean transection speed was measured as the transection area divided by transection time ($cm^2$/min) . And The transection area measured immediately by putting the cut surface of the graft on a sterile paper sheet and the surface is drown on it and cut , the cut paper then scanned by a computer scanner and the surface area is measured .

The remaining liver was assessed daily until hospital discharge, the assessment parameters include: bilirubin level, ALT and AST level and PTT.

Statistical analysis was done using the GraphPad software. The significance level was set at $P<0.05$. Analysis include t-test, Fisher's exact test or Chi-square test.

**Table I:** Patient Demographics & Surgical Characteristics

| Transection technique | CUSA | Clamp crushing | P value |
|---|---|---|---|
| Gender(F/M) | 19/23 | 18/30 | >0.05 |
| Mean age (in years) | 37 | 36 | >0.05 |
| Right hepatectomy ( number of cases) | 37 | 40 | >0.05 |
| Left hepatectomy ( number of cases) | 4 | 6 | >0.05 |
| Left lateral segmeentectomy ( number of cases) | 1 | 2 | >0.05 |
| Total cases | 42 | 48 | |

## Results

A total of 90 patients analyzed in this study, Patient Demographics & Surgical Characteristics(the use of ligatures, clips and bipolar diathermy) was similar in both techniques of transection Table I.

Clamp crushing technique was used in 48 donors (group A), while Cavitron ultrasonic surgical aspirator

(CUSA) was used in 42 donors (group B), both techniques used during the study are selected randomly over the period of the study.

The mean blood loss was significantly lower in the clamp crush technique group (345 ml) than the CUSA group (410ml) ranging (195-480 ml) (P value 0.0092); the transection time and speed was shorter in the clamp crush group but not statically significant (Table II, fig 1).There were no significant differences between both groups in term of postoperative hepatocyte injury (AST and ALT levels), bilirubin and INR. There was no significant difference in the ICU stay (P value 0. 6620) and hospital stay (P value 0. 3208) in both groups.( Table III ,fig. 2)

No significant difference regarding the postoperative complications in both groups, 7 patient's developed superficial wound infection 4 in group A and 3 in group B, atelectasis or pleural effusion occur in 11 patients, 6 in group A and 5 in group B, 1 patient in group A developed pneumonia, biloma occur in 3 cases, one in group A and 2 in group B, incisional hernia occur in 2 patients on in each group. (Table IV, fig. 3) There was no mortality in both groups.

**Table II:** Intra-operative Transection-Related Features

| **Transection technique** | **CUSA(n 42)** | **Clamp crush(n 48)** | **P value** |
|---|---|---|---|
| Mean transection speed (cm2/min) | 0.5 ±0.3 | 0.4 ±0.2 | 0.1848 |
| Duration of transection in minutes | 92(65-135) | 74(53-117) | 0.0766 |
| Mean blood loss (ml) | 410 (275-730) | 345(195-480) | 0.0092 |
| No. of transfused patients | 3 | 2 | 0.2231 |

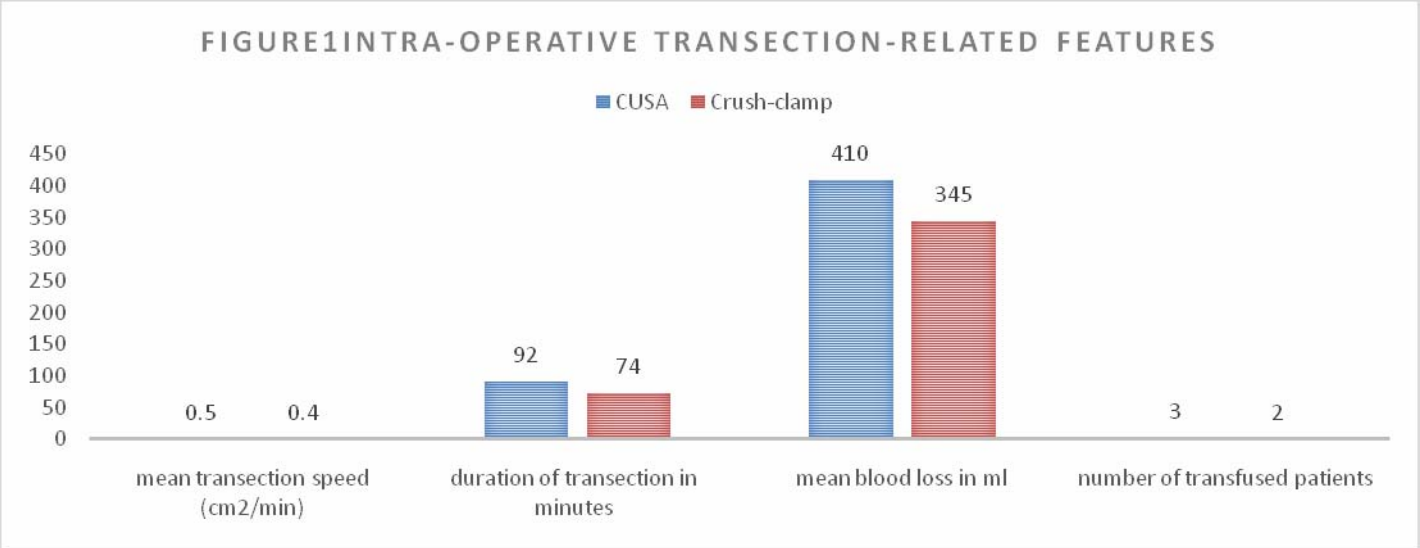



**Table III:** postoperative results

| Postoperative result | CUSA (n 42) | Clamp crush (n 48) | P-Value |
|---|---|---|---|
| AST (mean) | 138 | 145 | 0.6475 |
| ALT (mean) | 190 | 183 | 0.2389 |
| INR (mean) | 1.3 | 1.4 | 0.5494 |
| Mean bilirubin level (mg/dl) | 2.9 | 3.1 | 0.3916 |
| Mean hospital stay (days) | 7(5-11) | 6 (4-9) | 0.3208 |
| Mean ICU stay(days) | 1.5(1-3) | 1.8(1-3) | 0.6620 |

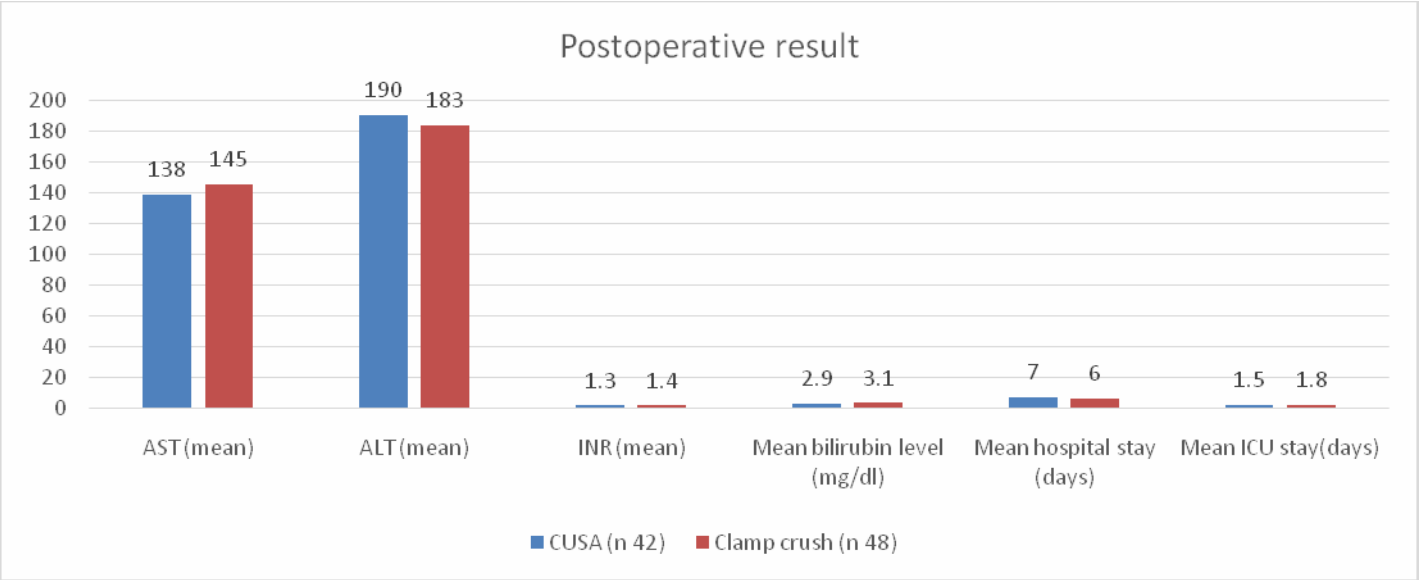
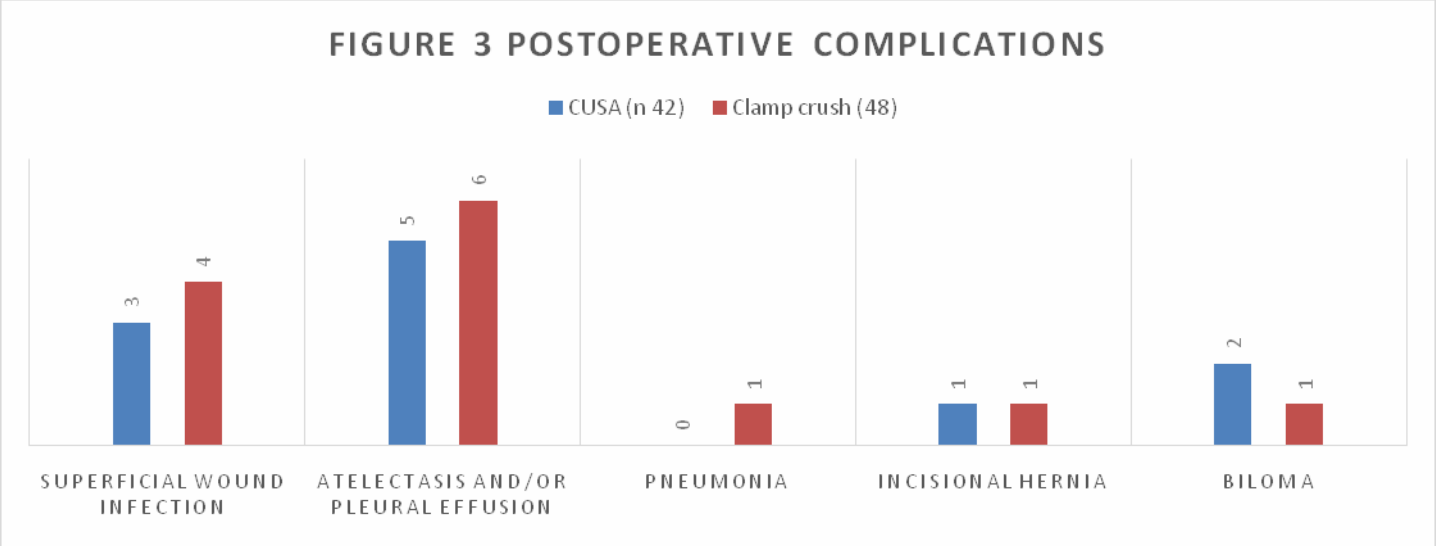



**Table IV:** postoperative complications

| Transection technique | CUSA | Clamp crush | P value |
|---|---|---|---|
| Superficial wound infection | 3 | 4 | 0.5578 |
| Atelectasis and/or pleural effusion | 5 | 6 | 0.5438 |
| Pneumonia | 0 | 1 | 1.0000 |
| Incisional hernia | 1 | 1 | 0.3173 |
| Biloma | 2 | 1 | 0.1573 |




## Discussion

The first human liver transplant from deceased donor was performed in 1963 by a surgical team led by Dr. Thomas Starzl[(1)] from Denver, Colorado, United States. Because of the short supply of liver allografts from deceased donors, a reality that has spurred the development of living donor liver transplantation. The first report of successful LDLT was performed by Dr. Christoph Broelsch at the University Of Chicago Medical Center in November 1989 for a pediatric recipient. Surgeons eventually realized that adult-to-adult LDLT was also possible, and now the practice is common in a few reputable medical institutes. Since that time, an increased numbers of LDLT is done in many centers worldwide. The most significant operative hazard during major liver resection is uncontrolled bleeding.[(2)] Avoiding excessive blood loss is the most important factor affecting peri-operative outcome, and there is a close relationship between increasing blood loss during transection and an unfavorable result.[(3)] Because donor safety comes first, various methods of liver parenchymal transection have been suggested to decrease blood loss and blood transfusion during hepatic parenchymal transection. These include the clamp–crush technique (Kelly's technique).[(4-6)] Cavitron ultrasonic surgical aspirator (CUSA),[(7-8)] the radiofrequency dissecting sealer (RFDS),[(5-6)] and several other techniques.

Some of these devices have gained wide acceptance for hepatectomy, although, to our knowledge, their efficacy has been tested in many randomized controlled trials (RCTs) comparing several devices to each other including, clamp crushing technique , CUSA, Hydrojet, and several other devices, and none of them proved superiority to simple clamp crushing technique [2,4,5]

The current study showed that clamp crush technique in LDLT is a safe technique, in term of the amount of blood loss during parenchymal transection when compared to other devices such as CUSA. Several trials compared outcomes between the clamp–crush technique and CUSA, and shows no overall statistical significant difference between the two techniques, however the amount of blood loss and blood transfusion is more in the CUSA technique.[5-6,8]the transection speed is superior in clamp crush technique compared to CUSA, the postoperative hepatocyte injury is similar in both clamp crush and CUSA groups.[9-11] No additional or significant postoperative complication occurred in the clamp crush technique.[10-11] also, clamp–crush technique has been found to be a safe and effective method of parenchymal division with significantly less blood loss when compared to CUSA.[12]

It is surprising that often expensive devices are introduced in routine surgical practice without firm proof of superiority and efficacy over simpler and cheaper techniques. This is most important especially in developing countries such as Jordan, where the cost of such devices create an economic burden on health care systems, therefore the appropriateness of introduction of such expensive transection devices should be investigated thoroughly when a simpler devices with similar efficacy are available.

## Conclusion

There is no apparent over all advantage of CUSA over the Clamp-crush technique in living donor liver transplantation with similar outcome in both groups; However the Clamp-crush technique was favorable in terms of operative blood loss

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