Surg Endosc (2010) 24:2755–2759
DOI 10.1007/s00464-010-1040-z

The feasibility of solo-surgeon living donor nephrectomy: initial experience using video-assisted minilaparotomy surgery

Yong Seung Lee · Hwang Gyun Jeon · Seung Ryeol Lee · Woo Ju Jeong · Seung Choul Yang · Woong Kyu Han

Received: 11 August 2009 / Accepted: 17 March 2010 / Published online: 10 April 2010

Abstract
Background Today, many kinds of surgery are being conducted without human assistants. Living donor nephrectomy (LDN) using video-assisted minilaparotomy surgery (VAM) has been performed by solo-surgeon using Unitrac® (Aesculap Surgical Instrument, Germany). We examined the results from VAM–solo-surgeon living donor nephrectomy (SLDN) and conventional VAM–human-assisted living donor nephrectomy (HLDN).
Methods Between July 2007 and April 2008, 82 cases of VAM–LDN were performed by two surgeons. From these cases, we randomly assigned 35 cases to undergo solo-surgery (group I) and the other 47 cases to undergo surgery with one human assistant (group II). All VAM–LDN procedures were performed in the same manner. Only the roles of a first assistant were substituted by the Unitrac® in group I. We compared the perioperative and postoperative data, including operative time, estimated blood loss, and hospital stay, between the two groups. We also investigated cases that developed complications.
Results There were no significant differences in the patient demographic data between the two groups ($P > 0.05$). The mean operative time was 201.9 ± 32.9 min in group I and 202.4 ± 48.3 min in group II ($P = 0.954$), whereas mean blood loss was 209.7 ± 167.3 ml in group I and 179.6 ± 87.8 ml in group II ($P = 0.294$). Postoperative hospital stay were 5.4 ± 1.1 days in group I and 5.5 ± 1.6 days in group II ($P = 0.813$). The incidence of perioperative complications was not significantly different between the two groups.
Conclusions Our study demonstrates that VAM–SLDN can be performed safely, is economically beneficial, and is comparable to VAM–HLDN in terms of postoperative outcomes.

Keywords Living donor nephrectomy · Solo-surgery · Kidney transplantation

Y. S. Lee · H. G. Jeon · S. R. Lee · W. J. Jeong · S. C. Yang · W. K. Han (✉)
Department of Urology, Urological Science Institute, Yonsei University College of Medicine, 134, Shinchon-dong, Seodaemun-gu, Seoul 120-752, Korea
e-mail: hanwk@yuhs.ac

Y. S. Lee
e-mail: asforthelord@yuhs.ac

H. G. Jeon
e-mail: YELLOWBAC@yuhs.ac

S. R. Lee
e-mail: ryeol@yuhs.ac

W. J. Jeong
e-mail: urojeong@yuhs.ac

S. C. Yang
e-mail: syang313@yuhs.ac

Recently, contemporary demand for minimally invasive surgery has resulted in the development of new surgical techniques and instruments. The development of surgical instruments has increased medical costs but decreased the necessity of human assistance compared with conventional open surgery. These phenomena have been accompanied by the development of solo-surgery, in which human assistance is replaced by instruments, such as a scope holder.

Solo-surgery was tried for the first time in early 1990, mainly in the general surgery field. In 1995, Partin et al. and Kavoussi et al. reported their initial experiences using solo-surgery in urologic surgery [1, 2]. Recently, in almost every field of surgery, including general surgery, thoracic surgery, and neck surgery, many kinds of minimally invasive surgery are performed as solo-surgery [3–7]. However, there have been no reports on the use of solo surgery with living donor nephrectomy (LDN).

At our institutes, there have been more than 1,800 cases of VAM–LDN since 1993 [8]. With VAM–LDN, the well-developed traction system has limited the role of a human assistant as a telescope holder [9]. Human assistants inevitably have tremor and are inclined to lose horizontal orientation. Also, there are frequent delays due to cleaning the lens after inadvertent contact of the telescope with the tissue. To remove the burdens associated with human assistance, we started to perform solo-surgery using Unitrac® (Aesculap Surgical Instrument, Germany) in VAM-LDN in July 2007. To investigate the safety and feasibility of solo-surgery, we compared VAM–solo-surgeon living donor nephrectomy (SLDN) with conventional VAM–human-assisted living donor nephrectomy (HLDN).

Materials and methods

Between July 2007 and April 2008, 82 cases of VAM–LDN were performed by two surgeons. There were 35 cases randomly assigned to the VAM–SLDN group (group I), and conventional surgery with one human assistant was performed for the other 47 cases (group II). Unless the recipient had previously experienced kidney transplantation, the left kidney was selected for donation.

Surgical techniques

All the VAM–LDN procedures were performed as described by Yang et al. [8]. Only the roles of a first assistant were substituted by the Unitrac® in group I. The patient was placed in a semilateral position with the contralateral knee flexed and the ipsilateral arm stretched. A kidney rest was elevated and the table was flexed to tense the lateral abdomen. A video system, including a television monitor and Unitrac® were placed across the table from the surgeon (Fig. 1). In conventional VAM–HLDN, one surgeon and one assistant are on the same side of the patient while performing the operation. The assistant works primarily with the telescope and light source and partially with the piercing peritoneal wall retractor. The role of the first assistant as a telescope holder was substituted by the Unitrac® in this study.

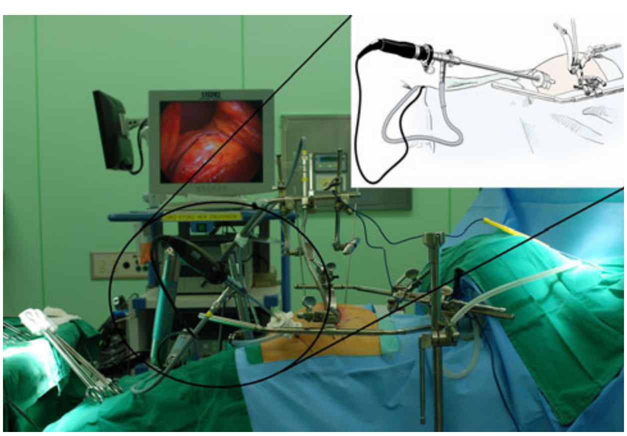

Fig. 1 Configuration of the assembly of instruments for solo-surgeon living donor nephrectomy using video-assisted minilaparotomy

Data collection

We had prospectively collected perioperative data for the patients, including age, gender, laterality of transplanted kidney, operative time, and estimated blood loss. Postoperative data, such as postoperative drainage removal day and postoperative hospital stay, were compared between the two groups. We also tried to collect complicated cases, such as inadvertent organ injury, conversion to open surgery and prolonged drainage. In group I, conversion to human-assisted surgery also was checked.

Statistical analysis

We compared age, operative time, estimated blood loss, postoperative hospital stay, and postoperative drainage removal day between the two groups using the Student's *t* test, whereas gender ratio, laterality of transplanted kidney, and complication rates were compared using the chi-square test. $P < 0.05$ was considered to be significant. Statistical analyses were conducted using the SPSS version 12.0 (SPSS Inc., Chicago, IL).

Results

We analyzed the perioperative data and postoperative data (Table 1). There were no significant differences in patient demographics. Average patient ages were 40.9 ± 10.6 years in group I and 39.2 ± 10.5 years in group II ($P = 0.468$); the gender ratio was not significantly different ($P = 0.655$). Seven of 35 cases in group I (20%) were right kidney transplantation, whereas 7 of 47 cases in group II (14.9%) were right kidney transplantation ($P = 0.567$).

There were also no significant differences in perioperative data and postoperative data between the two groups. The mean operative time of 201.9 ± 32.9 min in group I was similar to 202.4 ± 48.3 min in group II ($P = 0.954$). There was more mean blood loss in group I (209.7 ± 167.3 ml)

Table 1 Patient demographics and operative data compared between VAM solo-surgeon living donor nephrectomy and VAM human-assisted living donor nephrectomy

Variable	VAM–SLDN ($n = 35$)	VAM–HLDN ($n = 47$)	*P* value
Mean age (yr)	40.9 ± 10.6	39.2 ± 10.5	0.468
Gender (M:F)	22:13	27:20	0.655
Laterality (Lt:Rt)	28:7	40:7	0.567
Mean operative time (min)	201.9 ± 32.9	202.4 ± 48.3	0.954
Mean blood loss (ml)	209.7 ± 167.3	179.6 ± 87.8	0.294
Postoperative hospital stay (day)	5.4 ± 1.1	5.5 ± 1.6	0.813
Postoperative drainage removal (day)	3.5 ± 0.8	4.1 ± 2.0	0.068
Complications	0	3	0.257

VAM video-assisted minilaparotomy surgery, *HLDN* human-assisted living donor nephrectomy, *SLDN* solo-surgeon living donor nephrectomy

than in group II (179.6 ± 87.8 ml), but the difference was not statistically significant ($P = 0.294$). The postoperative hospital stays were 5.4 ± 1.1 days in group I and 5.5 ± 1.6 days in group II, which is not a statistically significant difference ($P = 0.813$). In group I, the interval between operation and drainage removal was 3.5 ± 0.8 days, which is shorter than the 4.1 ± 2.0 days in group II, but not significantly different ($P = 0.068$). There were no intraoperative complications such as major vessel tearing or organ damage. There was no conversion to open surgery in either group and no inadvertent need for a human assistant during any solo-surgery in group I. There were three cases in group II with complications during postoperative care. In two cases, the interval between operation and drainage removal was more than 10 days (11 days and 12 days, respectively), while in one case, there was severe postoperative scrotal swelling that was cured completely with conservative care.

Discussion

Recently, the development of surgical instruments has increased the use of solo-surgery. The basic instruments that enabled the use of solo-surgery were scope holders [10], such as the Leyla® (Aesculap), the Unitrac® (Aesculap) and the Endofreeze® (Aesculap) [11]. After using these kinds of simple mechanical manipulators, robotic systems controlled by finger or voice have been developed and applied to various solo-surgeries. Yoshino I et al. performed thoracic surgery using Naviot® (Hitachi, Inc., Japan) controlled by simple finger movement, which includes automatic micro-zoom function [6]. Antiphon et al. reported solo-surgery laparoscopic radical prostatectomy using AESOP 3000® (Computer Motion, Inc., Santa Barbara, CA) controlled by the surgeon's voice [12]. After the introduction of a more developed robotic system, more difficult and complex surgeries could be performed as solo-surgeries [13].

The use of solo-surgery has increased in various institutions for a number of reasons. The first reason is dissatisfaction with human assistance. Kavoussi et al. investigated the accuracy of a robotic surgical arm compared to a human surgical assistant during urologic laparoscopic surgery [2]. There were significantly more inadvertent tissue contacts and unnecessary movements with the human assistant than with the robotic surgical arm. Similar results were reported by Antiphon et al. from a study of solo-surgery laparoscopic radical prostatectomy where the results of solo-surgeon laparoscopic radical prostatectomy were compared with those of standard prostatectomy [12]. The mean operative time with the solo-surgeon group was 324 min, which was less than the 347 min of the standard group, although the difference between the two groups was not statistically significant. These results suggest that the goal of solo-surgery is to get the same results with better outcomes than achieved with human assisted surgery. In our study, we obtained similar operative times with the two approaches. Despite the time spent on device settlement, the mean operative time in group I (201.9 ± 32.9 min) was not longer compared to that of group II (202.4 ± 48.3 min, $P = 0.954$). Considering that the 35 cases of VAM–SLDN considered in this study were the first attempts at solo-surgery at this institution, we will probably achieve better results as we become more familiar with the process.

Another reason for the introduction of solo-surgery is the practical problems of each institution. Antiphon et al. mentioned the shortage of operative assistance at small- or medium-sized institutions [12]. In Korea, these situations are also common in tertiary medical centers where the number of doctors is not sufficient to conduct all of the necessary surgeries. The use of SLDN has improved this situation in our institution.

The use of solo-surgery also is economically advantageous. Today, the rapid increase in medical costs is followed by pressure from the government or insurance companies. Kok et al. reported the cost effectiveness of laparoscopic versus mini-incision open donor nephrectomy [14]. They investigated the social and perioperative costs spent during the first year after operation between the two groups. However, this kind of investigation is unnecessary for VAM–SLDN, as there was no change in the procedure except for the substitution of human assistance with a mechanical scope holder. The equivalent operative times between the two groups shows the economical benefit of VAM–SLDN.

We had some concern about the safety of solo-surgery before starting the VAM–SLDN. However, there were no significant differences in mean blood loss between the two groups and no conversion to open surgery or human-assisted surgery. There were three cases of postoperative complication in group II, including two cases of prolonged drainage and one case of scrotal swelling. Regarding the statistical insignificance and lower severity of the complications, we cannot conclude that there were better operative outcomes with VAM–SLDN than with VALN–HLDN. Moreover, our study did not encounter an emergent situation, such as vessel tearing, during our 82 cases of VAM–LDN, so we were not able to analyze performance under this circumstance. Performing VAM–SLDN in more cases will increase the odds of encountering a complication, and will confirm our assessment of its safety.

In our institute, the solo-surgery was limited to VAM–LDN. We could not apply this kind of solo-surgery to other kinds of complex urologic surgery like radical prostatectomy or radical cystectomy, for which the role of human assistance is more critical. The ability to use a more developed device will allow the performance of more types of solo-surgeries. However, to maintain the economic advantage of solo-surgery, it is more important to use a proper device than to use a highly developed device. Based on this assessment, the Unitrac® was sufficient for use with VAM–LDN (Fig. 2).

Fig. 2 Solo-surgeon living donor nephrectomy using video-assisted minilaparotomy

Conclusions

We performed 35 cases of solo-surgeon VAMS donor nephrectomy using the Unitrac®. The solo-surgeon VAMS donor nephrectomy and human-assisted VAMS donor nephrectomy showed similar operative outcomes. However, as far as the cost is concerned, the solo-surgeon VAMS donor nephrectomy seemed to offer more advantages than the human-assisted VAMS donor nephrectomy. Therefore, solo-surgery could be a safe and economical substitution for human-assisted surgery.

Disclosures Y. S. Lee, H. G. Jeon, S. R. Lee, W. J. Jeong, S. C. Yang, and W. K. Han have no conflicts of interest or financial ties to disclose.

References

1. Partin AW, Adams JB, Moore RG, Kavoussi LR (1995) Complete robot-assisted laparoscopic urologic surgery: a preliminary report. J Am Coll Surg 181:552–557
2. Kavoussi LR, Moore RG, Adams JB, Partin AW (1995) Comparison of robotic versus human laparoscopic camera control. J Urol 154:2134–2136
3. Flores RO, Zermeño JN, Martínez AM, Vera MG, Nieto Miranda JJ, Espinoza DL (2007) Laparoscopic Nissen solo surgery using PMAT (first experience). Minim Invasive Ther Allied Technol 16:347–349
4. Kalteis M, Pistrich R, Schimetta W, Pölz W (2007) Laparoscopic cholecystectomy as solo surgery with the aid of a robotic camera holder: a case-control study. Surg Laparosc Endosc Percutan Tech 17:277–282
5. Tanoue K, Yasunaga T, Kobayashi E, Miyamoto S, Sakuma I, Dohi T, Konishi K, Yamaguchi S, Kinjo N, Takenaka K, Maehara Y, Hashizume M (2006) Laparoscopic cholecystectomy using a newly developed laparoscope manipulator for 10 patients with cholelithiasis. Surg Endosc 20:753–756
6. Yoshino I, Yasunaga T, Hashizume M, Maehara Y (2005) A novel endoscope manipulator, Naviot, enables solo-surgery to be performed during video-assisted thoracic surgery. Interact Cardiovasc Thorac Surg 4:404–405
7. Rulli F, Galatà G, Pompeo E, Farinon AM (2007) A camera handler for Miccoli's minimally invasive video-assisted thyroidectomy and parathyroidectomy procedures. Surg Endosc 21:1017–1019
8. Yang SC, Ko WJ, Byun YJ, Rha KH (2001) Retroperitoneoscopy assisted live donor nephrectomy: the Yonsei experience. J Urol 165:1099–1102
9. Rha KH, Kim YS, Kim SI, Byun YJ, Hong SJ, Park K, Yang SC (2004) Video-assisted minilaparotomy surgery (VAMS)–live donor nephrectomy: 239 cases. Yonsei Med J 45:1149–1154
10. Jaspers JE, Breedveld P, Herder JL, Grimbergen CA (2004) Camera and instrument holders and their clinical value in minimally invasive surgery. Surg Laparosc Endosc Percutan Tech 14:145–152
11. Arezzo A, Schurr MO, Braun A, Buess GF (2005) Experimental assessment of a new mechanical endoscopic solo surgery system: endofreeze. Surg Endosc 19:581–588
12. Antiphon P, Hoznek A, Benyoussef A, de lataille A, Cicco A, Elard S, Gettman MT, Katz R, Vordos D, Salomon L, Chopin DK,

Abbou CC (2003) Complete solo laparoscopic radical prostatectomy: initial experience. Urology 61:724–728 discussion 728
13. Drasin T, Dutson E, Gracia C (2004) Use of a robotic system as surgical first assistant in advanced laparoscopic surgery. J Am Coll Surg 199:368–373
14. Kok NF, Adang EM, Hansson BM, Dooper IM, Weimar W, van der Wilt GJ, Ijzermans JN (2007) Cost effectiveness of laparoscopic versus mini-incision open donor nephrectomy: a randomized study. Transplantation 83:1582–1587