Master's degree

Solo-Surgeon Pure Laparoscopic Living Donor Nephrectomy Using Passive Camera Holder: Pilot Study

The Graduate School of the University of Ulsan

Department of Medicine

Dong Hyeon An

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Supervisor : Dalsan You

A Dissertation

Submitted to
the Graduate School of the University of Ulsan
In partial Fulfillment of the Requirements
for the Degree of

Master in medicine

By

Dong Hyeon An

Department of Medicine

Ulsan, Korea

February 2020

Solo-Surgeon Pure Laparoscopic Living Donor

Nephrectomy Using Passive Camera Holder: Pilot Study

This certifies that the dissertation

of Dong Hyeon An is approved.

Bumsik Hong

Committee Chair M.D., Ph.D.

In Gab Jeong

Committee Member M.D., Ph.D.

Dalsan You

Committee Member M.D., Ph.D.

Department of Medicine

Ulsan, Korea

February 2020

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ABSTRACTS

INTRODUCTION: Safe surgery is of utmost importance for living kidney donors undergoing surgery that is not intended for their health. This leads to the development of minimally invasive donor nephrectomy techniques. For stable surgery during laparoscopic surgery, Surgical vision as seen on the camera should be provided to the surgeon stably. The camera holder can provide the stable surgical vision intended by the surgeon without shaking. Solo-surgery can be defined as a practice of a surgeon operating alone using a camera holder, without other surgical members except for a scrub nurse. This IDEAL stage 2a study was designed to evaluate the feasibility and safety of solo-surgeon pure laparoscopic living donor nephrectomy (SSPLDN).

MATERIALS AND METHODS: The study protocol was approved by the institutional review board of the Asan Medical Center, Seoul, Korea (#2018-0864) and registered on the Clinical Research Information Service site of the Korea Centers for Disease Control and Prevention (#KCT0003458). The patients eligible for all inclusion and exclusion criteria were enrolled in clinical trial and SSPLDN was performed. The feasibility was assessed by the proportion of subjects who could perform SSPLDN without difficulty. The perioperative complications were identified to assess the safety of SSPLDN.

RESULTS: Of the 47 potential candidates from November 2018 to August 2019, 40 were enrolled in clinical trial and seven excluded due to declining participation. The feasibility was 100% (40/40). There were fourteen minor intraoperative complications in 10 cases and seventy three minor postoperative complications in 34 cases. Major perioperative complications did not occur. There were no postoperative complications under the influence of solo-surgery. The mean total operation time was 175.6 ± 27.8 minutes and the longest total operation time was 235 minutes.

CONCLUSIONS: SSPLDN using passive camera holder is technically feasible and safe.

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INTRODUCTION

The first successful kidney transplantation between living patients was performed in 1954 in the United States.[1)] Subsequently, living donor kidney transplantation has been shown to be superior to deceased donor kidney transplantation due to short cold ischemia time, perfect kidney condition by healthy donors, and reduced waiting times for recipients.[2-4)] Safe surgery is of utmost importance for living kidney donors undergoing surgery that is not intended for their health. Therefore, Surgeons performing living-donor kidney transplantations have focused on the quality of life and safety of the donor, as well as graft function. Because kidney donors do not undergo surgery for their own health, their demand for minimally invasive surgery is higher. These lead to the development of minimally invasive donor nephrectomy techniques such as hand-assisted or pure laparoscopic donor nephrectomies. In this trend, the first pure laparoscopic living donor nephrectomy was reported by Ratner et al. in 1995.[5)]

For stable surgery during laparoscopic surgery, the assistant who holds a camera should keep the image stable, pose the surgical site in the center of the monitor, and provide an unrotated image. However, since the human assistant is mostly a resident, it is difficult to accumulate experience by maintaining a stable technique continuously. Even experienced assistants suffer from the difficulty of maintaining stable images because fatigue accumulates. Human assistants to hold a camera tend to have a tremor and lose horizontal orientation. Also, there are frequent interruptions due to cleaning the lens after unintentional contact of the camera with the tissue.[6)] The camera holder has been developed to overcome these problems and has the advantage of maintaining the camera stably without shaking. Through the use of a camera holder, a surgeon can perform surgery without the human assistant during laparoscopic surgery, which is called a solo-surgery. Solo-surgery can be defined as a practice in which a surgeon operates alone, without other surgical members except for a scrub nurse.

Solo-surgery in the urology field was first reported in 1995 by Partin et al. and Kavoussi et al.[7, 8)] They performed prostate surgery using a robotic system rather than a camera holding system. Solo-surgery in living donor nephrectomy was first described in 2009 by Lee et al.[9)]

But their operation was technically video-assisted mini-laparotomy surgery, which not a minimally invasive surgery.

Because donor nephrectomy requires short renal ischemia and delicate detachment of renal vessels and ureter compared with radical or simple nephrectomy, pure laparoscopic living donor nephrectomy is technically demanding. On the ther hand, solo-surgery may take longer as the operator adjusts the camera position, and it may take time for medical personnel to arrive to assist in case of an unexpected emergency. In addition, the fixed camera may interfere with the operation, and there is a disadvantage in losing the opportunity to provide appropriate major education. Therefore, it is necessary to demonstrate the feasibility and safety of solo-surgeon pure laparoscopic living donor nephrectomy (SSPLDN). This IDEAL (Idea, Development, Exploration, Assessment, Long-term study) stage 2a study was designed to evaluate the feasibility and safety of SSPLDN.[10)]

MATERIALS AND METHODS

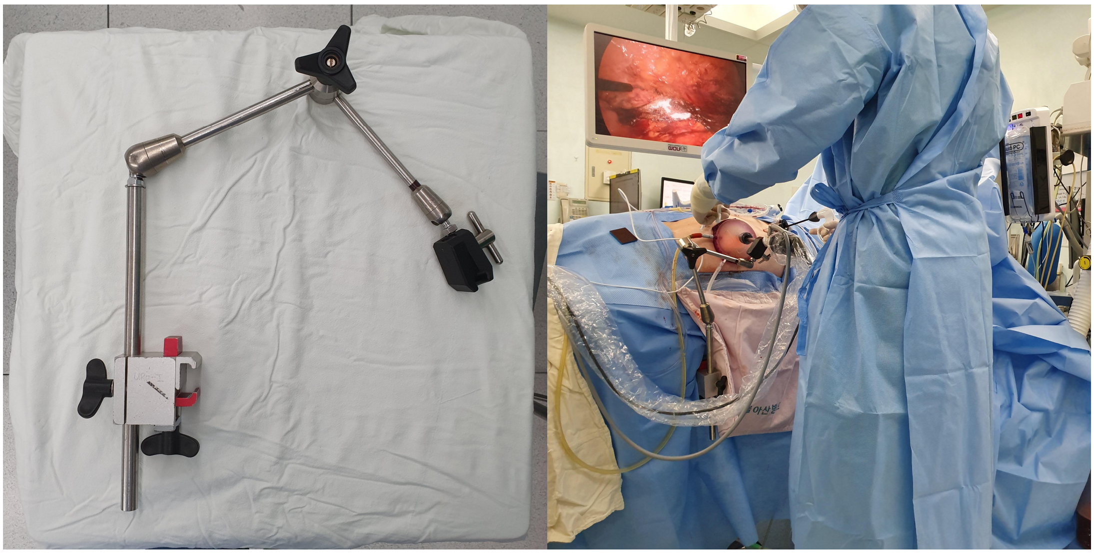
1. Study Design and Data Collection

The study protocol was approved by the institutional review board of the Asan Medical Center, Seoul, Korea (#2018-0864), and conformed to the tenets of the Declaration of Helsinki. The brief study protocol was registered on the Clinical Research Information Service site of the Korea Centers for Disease Control and Prevention (#KCT0003458). Potential candidates were living kidney donors who were able to properly speak Korean between 18 and 80 years old. Potential candidates provided written informed consent before participating in the clinical trial. Patients who were unable to undergo laparoscopic surgery due to prior abdominal surgery, who declined to participate in the clinical trial, and who were inadequate to participate in clinical trials by the discretion of physician, were excluded. The patients eligible for all inclusion and exclusion criteria were enrolled in clinical trial and SSPLDN was performed. The patients were assessed for feasibility and perioperative complications of SSPLDN. Additionally, baseline data, operative and convalescence parameters were prospectively collected. Baseline data included patient's age, sex, relationship to recipient, body mass index, medical and surgical histories, laterality, relative function, number of arteries and veins, hemoglobin concentration, glomerular filtration rate (GFR). GFR was estimated from serum creatinine concentration with a variation of the original Modification of Diet in Renal Disease.

2. Surgical Techniques

Most of the SSPLDN procedures were performed as described by You et al.[11] For right (left)-sided SSPLDN, patients were placed in a 45° oblique position with the left (right) side down, while under general anesthesia. A 6-cm omega-shaped incision was made around the umbilicus for insertion of the GelPOINT advanced access platform (Applied Medical, Rancho Santa Margarita, CA, USA). A 12-mm trocar was placed below the right (left) costal margin in the right (left) midclavicular line and a second 12-mm trocar was placed below the level of the umbilicus in the right (left) anterior axillary line. A 5-mm trocar was placed just below the xiphoid process for surgery on the right kidney and used for liver retraction. The assistant who holds a camera was replaced by the passive camera holder (FISSO, Zurich, Switzerland) (Fig. 1). After the white line of Toldt was incised and the colon reflected medially, Gerota's fascia was entered near the renal hilum. The renal artery and vein were completely freed of lymphatic and other perivascular tissue, avoiding any injuries to the vessels. The gonadal, lumbar, and adrenal branches were tied and divided from the renal vein. The ureter was dissected caudally to the level of the internal iliac vessels, leaving sufficient margins to ensure an adequate blood supply around it. Five thousands IU heparin were administered intravenously. An extra-large Weck® Hem-o-lok® polymer clip (Teleflex Inc., Morrisville, NC, USA) was applied at the caudal end of the dissected ureter, and the ureter was divided cephalad to the clip without electrocautery. An Endopath ETS-Flex articulating endoscopic linear stapler (Ethicon Endo-Surgery Inc., Cincinnati, OH, USA) was applied to transect the renal artery and vein. The kidney was removed through the umbilical incision in a LapBag (Sejong Medical Co. Ltd., Paju, Gyeonggi, Korea), placed immediately in sterile ice slush, and delivered to the recipient team for grafting. The scrub nurse assisted the solo-surgeon in extracting the donor kidney. After the abdomen was carefully inspected at a reduced intraperitoneal pressure, bleeding was controlled. Solo-surgery was performed from completion of laparoscopic port placement to completion of bleeding control. From skin incision to port placement and wound closure was with the assistant in usual method.

Fig. 1. Passive camera holder (FISSO, Zurich, Switzerland)



* The camera holding system consists of endoscope holder and rails clamp, and the endoscope holder consists of a 5×10 mm optic holder, a 400 mm articulated arm and a 16×400 mm straight column. The camera holding system is used by securing the endoscope holder to the operating table with a rail clamp.

3. Primary Outcome

Feasibility

We evaluated whether SSPLDN can be performed without difficulty. The difficulty is in three cases: First, if the operation is no longer possible with the SSPLDN due to a collision between the camera holder and the camera and the operator's hand or laparoscopic instrument. Secondly, if there is a complication that requires the help of an assistant during solo-surgery. And lastly, when solo-surgery time (from completion of laparoscopic port placement to completion of bleeding control) exceeds 120 minutes. In all three cases, the operation is converted to the human assisted pure laparoscopic donor nephrectomy. Evaluation criteria and reporting methods are the ratio of the subjects who underwent surgery as planned among who planned to receive the SSPLDN.

Perioperative Complications

The surgeon records all the intraoperative complications on the operation record and case report form. All operations are video-recorded and reviewed by two researchers (DHA & DY) to check for missing parts. Evaluation criteria and reporting methods follow the Satava classification of intraoperative complications.[12] Also, the researchers collected all information that could be regarded as a postoperative complication for 90 days through vital signs, laboratory tests, and physical examinations. The postoperative complications were classified into hematologic, infectious, gastrointestinal, procedural, vascular, metabolic, genitourinary, cardiac, respiratory, and other, and the severity was classified according to Clavien–Dindo classification of postoperative complications.[13] If the postoperative complications occur, the symptoms, start date, duration, intensity and causal relationship of the complications should be recorded in the case record. All perioperative complications would be investigated until the end of clinical trial visit. Vital signs during hospitalization were measured at least three times daily and assessed for systolic and diastolic blood pressure, pulse rate and body temperature. Laboratory test results were classified into normal and abnormal (clinical significance or not) according to the normal range of our institution. Physical examination included blood system, infection, gastrointestinal tract, interventional procedures, cardiovascular system, metabolism, reproductive/urinary tract, respiratory system, and other physical examinations. Major complication was defined as Satava classification grade III or Clavien-Dindo classification grade III or higher.

4. Secondary Outcome

The operative parameters (total operation time, warm ischemia time, estimated blood loss), the convalescence parameters (visual analogue pain score; VAS on postoperative day 1, VAS at discharge, interval to return to regular diet, hospital stay, postoperative hemoglobin, postoperative GFR), and the early graft outcomes were assessed in the study group. Total operation time was defined as the time between skin incision for placement of the first trocar and skin closure of the trocar wounds. Warm ischemia time was defined as the time from renal artery occlusion to immersion of the kidney in ice slush. Blood loss was estimated by the hemoglobin dilution method.[14] Early graft outcome is classified as excellent, slow, and delayed. Delayed graft function was defined as the need for renal replacement therapy within the first week after surgery. Non-dialyzed patients were divided into those with slow and excellent graft function, based on whether serum creatinine concentration on postoperative day 7 was higher or lower than 2.5 mg/dL, respectively.[15]

5. Statistical Analysis

Considering that the study period was one year, 40 persons, 80% of the annual donor nephrectomy (approximately 50) of surgeons performing solo-surgery in this clinical trial (DY), were decided as the target number of subjects. Quantitative data were expressed as the mean ± standard deviation (SD). The total operation and warm ischemia time were also shown as range. The analysis of feasibility was analyzed in intention-to-treat population. Perioperative complications and operative and convalescence parameters were analyzed in patients who underwent SSPLDN (actual-procedure-received population).

RESULTS

1. Patients Data

Of the 47 potential candidates from November 2018 to August 2019, 40 were enrolled in clinical trial and seven excluded due to declining participation. One patient was dropped out shortly after the surgery due to voluntary withdrawal of agreement. And then three and one patients were additionally dropped out at postoperative day# 90 due to voluntary withdrawal of agreement and failure to visit, respectively (Fig. 2). The baseline characteristics of enrolled patients are shown in Table 1.

Fig. 2. CONSORT diagram of IDEAL stage 2a study

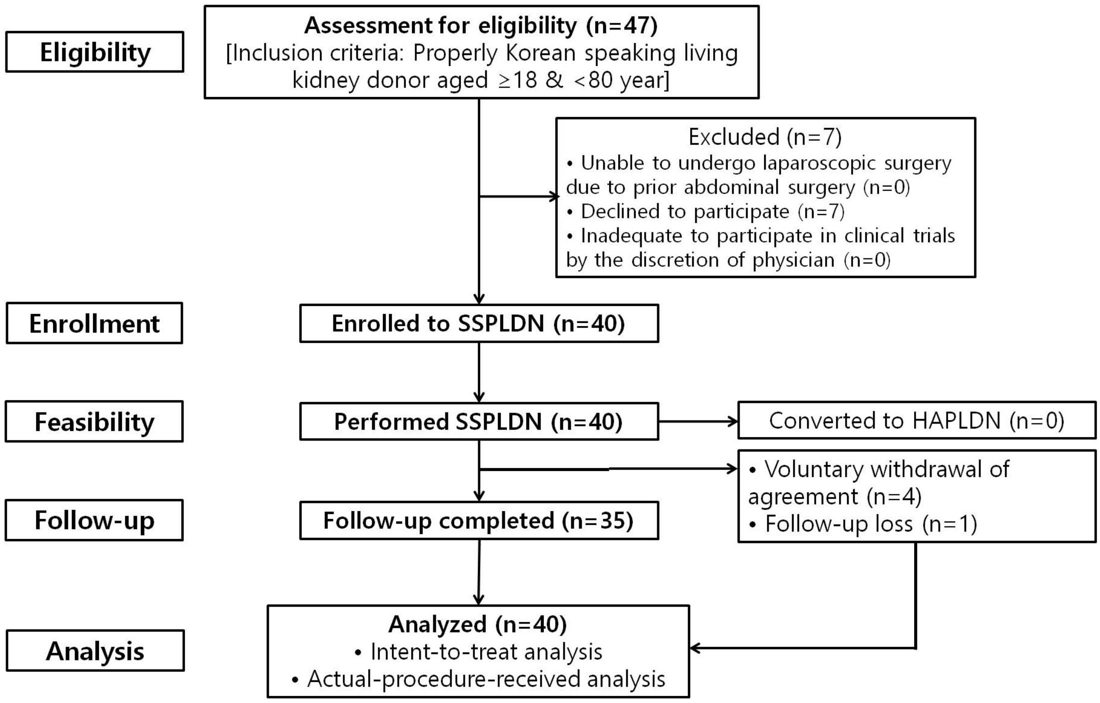


Table 1. Baseline characteristics	
Age, Mean ± SD, y	50.4 ± 10.1
Sex, male/female, n	15/25
Height, Mean ± SD, cm	162.6 ± 9.5
Body weight, Mean ± SD, kg	66.5 ± 11.5
Body mass index, Mean ± SD, kg/m^2	25.0 ± 2.4
Diabetes mellitus, n (%)	1 (2.5)
Hypertension, n (%)	6 (15)
Laterality, right/left, n	16/24
Arteries, n (%)	
1	32 (80)
2	7 (17.5)
3	1 (2.5)
Veins, n (%)	
1	31 (77.5)
2	7 (17.5)
3	1 (2.5)
4	1 (2.5)
Preoperative hemoglobin, Mean ± SD, g/dL	13.6 ± 1.57
Preoperative serum creatinine, Mean ± SD, mg/dL	0.75 ± 0.14
Preoperative GFR, Mean ± SD, mg/dL	99.7 ± 10.8

2. Primary Outcome

The solo-surgery time of all cases was less than 2 hours and no difficulty occurred that required conversion to the human assisted pure laparoscopic donor nephrectomy. The feasibility was 100% (40/40) and no major complications occurred. Fourteen minor intraoperative complications occurred in 10 cases (Table 2), most of which could be resolved immediately and no further examination or treatment was needed. There were a total of three intraoperative complications classified as the Satava classification grade II, two of which were due to malfunction of laparoscopic instruments, and another was due to the electrocoagulator during skin incision. There were no intraoperative complications associated with the Satava classification grade III. Seventy three minor postoperative complications occurred in 34 cases (Table 3). The most common postoperative complication was nausea/vomiting and the second was liver enzyme elevation. All liver enzyme elevation cases except one fatty liver history case occurred in right kidney surgery. There were no postoperative complications under the influence of solo-surgery and no postoperative complications that classified as the Clavien–Dindo classification grade III or higher.

Table 2. Intraoperative complications

Intraoperative complications, n (%)	14 (10/40, 25%)
Grade I, n	
Spleen injury	4
Liver injury	2
Colon injury	1
Ileum injury	1
Adrenal gland injury	1
Visceral peritoneum injury	1
Clip dislodge	1
Grade II, n	
Endo GIA firing fail and incomplete clipping	2
Colon thermal injury requiring repair	1

Table 3. Postoperative complications	
Postoperative complications, n (%)	73 (34/40, 85%)
Grade I, n	
Liver enzyme elevation	7
Lower urinary tract symptoms	4
Chest discomfort	3
Numbness	3
Wound problem	3
Nausea/Vomiting	2
Headache	2
Shoulder/arm pain	2
General edema	1
Rt ochialgia	1
Abdominal pain	1
Fever	1
Diarrhea	1
Hypoxia	1
Grade II, n	
Nausea/vomiting	20
Cough	3
Shoulder/arm pain	3
Skin erosion/Contract dermatitis	3
Liver enzyme elevation	2
Eyeball pain & hyperemia	2
Prickling on Neck	1
Constipation	1
Neck pain	1
Abdominal distension	1
Hypertension	1
Sleeping tendency	1
Low urine output	1
Transfusion	1

3. Secondary Outcome

The operative and convalescence parameters are shown in Table 4 and 5, respectively. The mean total operation and warm ischemic time were 175.6 ± 27.8 and 4.2 ± 1.8 minutes, respectively. The mean hospital stay was 5 ± 1.1 days. Of the 40 cases, 38 and two recipients showed excellent and slow graft function, respectively.

Table 4. Operative parameters	
Total operation time, Mean ± SD, range, minutes	175.6 ± 27.8, 123-235
Warm ischemic time, Mean ± SD, range, minutes	4.2 ± 1.8, 2-10
Estimated blood loss, Mean ± SD, mL	466.2 ± 263.3

Table 5. Convalescence parameters

Postoperative hemoglobin, Mean ± SD, g/dL	11.8 ± 1.3
Postoperative serum creatinine, Mean ± SD, mg/dL	0.95 ± 0.20
Postoperative GFR, Mean ± SD, mg/dL	79.7 ± 13.3
Hemoglobin on postoperative day 30, Mean ± SD, g/dL	13.2 ± 1.2
Serum creatinine on postoperative day 30, Mean ± SD, mg/dL	1.05 ± 0.21
GFR on postoperative day 30, Mean ± SD, mg/dL	71.7 ± 14.7
Hemoglobin on postoperative day 90, Mean ± SD, g/dL	13.4 ± 1.2
Serum creatinine on postoperative day 90, Mean ± SD, mg/dL	1.04 ± 0.21
GFR on postoperative day 90, Mean ± SD, mg/dL	68.1 ± 11.4
VAS on postoperative day 1, Mean ± SD	4.1 ± 1.6
VAS at discharge, Mean ± SD	1.4 ± 1.0
Interval to return to regular diet, Mean ± SD, days	3.0 ± 0.9
Hospital stay, Mean ± SD, days	5 ± 1.1

DISCUSSION

Since the introduction of laparoscopic surgery, several advantages have been demonstrated in terms of postoperative pain and recovery time. Compared to open surgery, fewer wounds in the abdomen, less manpower needed during surgery are the advantages of laparoscopic surgery, and less invasive techniques such as reduced ports or single port laparoscopic surgery are currently in progress.[16)] In keeping with these changes, the introduction of solo-surgery to reduce the number of assistants has begun. Recently, the development of surgical instruments has facilitated the use of solo-surgery.[17)] The basic instruments which enabled surgeons to perform the solo-surgery were camera holders. Depending on how the camera holder is operated, it is divided into active and passive. The active camera holder is operated by an electric motor and uses a head movement, a voice, a finger or a foot operated switch, etc. as a user interface for operating the camera holder. Representative active camera holders include AESOP robots (Automated Endoscopic System for Optimal Positioning robots; Computer Motion, Coletta, CA, USA) and EndoAssist (Armstrong Healthcare Ltd, High Wycombe, UK). Passive camera holders are hand-controlled, and are subdivided into one-handed [Unitrack (AESCULAP, Tuttlingen, Germany); Endofreeze (AESCULAP); Laparostat (CIVCO, Carolville, IA, USA)] and bimanual types [Martin arm (Gebuder Martin, Tuttlingen, Germany); Karl Storz Holding system (Karl Storz, Tuttlingen, Germany); Assisto (GEOMED, Tuttlingen, Germany)].

Although we used bimanual passive camera holder, the more innovative camera holders such as pneumatic camera holder (POINT SETTER™, Karl Storz), robotic holding system (ViKY, Endocontrol Medical, Grenoble, France), Magnetically Anchored and Guided Systems (MAGS) have additional advantages. Pneumatic holding system can be easily moved with one hand and robotic holding system can be easily moved with one foot or voice, reducing the time required to modulate the camera.[18)] The improved optics of the MAGS camera described by Sara L et al.[19)], paired with its ability as a MAGS instrument to be placed anywhere along the abdominal wall, allows the operator to work with the same viewing angle that would be achieved with conventional laparoscopy. In addition, there is room for camera port elimination.

The characteristics of solo-surgery were derived from replacement of human assistants with these camera holders. That point had several advantages. First of all, solo-surgeon get the steady field of view they intended. Human assistants without enough experience of surgery could not provide a steady field of view and these incompatible views made the operator uncomfortable. Because solo-surgeon modulated camera holder as intended, discomfort due to unintended views did not occur. Secondly, Since there was no human assistant, more freedom was made in the space of the solo-surgeon. By using alone the space shared with the assistants, the movement became easier and there was less room for the operation to be interrupted. Additionally, manpower allocation for human assistants were also efficient. Particularly, there was a merit that the manpower could be used more efficiently in the area where there is a shortage of resident manpower due to the decrease in resident support such as Canada, Taiwan, and Korea.[20-22] There were also some disadvantages. If you are unfamiliar with the use of the camera holder, a fixed camera holder might rather interfere with the movement of the solo-surgeon. Unlike the assistant who can move cooperatively, the camera holder was fixed from the beginning to the end of the operation, so if it is fixed in the wrong position, it might interfere with the operation and required skill in positioning the camera holder. In addition, the absence of medical personnel to cope with emergencies can be a problem. In this regard, our hospital secured a manpower to respond immediately to wired contact and then proceeded to surgery. Although emergencies are rare, this is an important part of manpower management. There may also be concerns that surgical training for residents will be difficult. Surgical training, however, is not significantly different between laparotomy and laparoscopic surgery and so is solo-surgery. The residents can improve understanding of the operation through theoretical learning and observation, and then learn the entire course of the operation by repeating the role of the surgeon on a section-by-section basis.[6]

Given these shortcomings, the SSPLDN can be a good choice as the first start of the solo-surgery. There is no change in the normal anatomy due to the disease and only normal variation, so the possibility of unexpected error during operation is low. At the beginning of this study, bimanual manipulation of the passive camera holder was easy to learn and did not occur any difficulties that would make the solo-surgery impossible in all cases. The feasibility was reported to be 100% (40/40). Intraoperative and postoperative complications were not associated with Satava and Clavien-Dindo classification grade 3 or higher, respectively, so there was no problem in terms of safety.

The most common postoperative complication was nausea/vomiting, which may be due to the intravenous patient-controlled analgesia (IV-PCA) used to control postoperative pain. In one case of transfusion, the transfusion was not required as an objective indicator, but the transfusion was performed at the time of on-call by subjective judgment of the resident. Hypoxia and sleeping tendency occurred in one patient at the same time, which was recovered immediately after intravenous naloxone, suggesting that excessive sedation by IV-PCA was the cause. Two patients with eyeball pain and hyperemia were diagnosed with uveitis, but the cause was unclear. Operative and convalescence parameters were similar between donors of this study and donors who had undergone human assisted pure laparoscopic living donor nephrectomy at our institution from 2014 to 2017.[23)] Although the comparison did not consider operation learning curves, it will be meaningful because it is a comparison with the data until almost immediately before we started SSPLDN. In two cases with slow early graft outcome, the warm ischemic time was 4 minutes in both cases and the total operation time was 164 and 172 minutes, respectively. The slow graft outcome in these two cases was not considered to be related to the operative parameters, and the most likely cause was the carbapenem resistant enterobacteri and vancomycin resistant enterococcus identified after the use of postoperative immunosuppressive agents.

To our knowledge, this study is the first to prospectively evaluate the feasibility and safety of SSPLDN. Although this study determined the feasibility and safety of the SSPLDN, a randomized controlled trial would be needed to clarify the benefits compared to human assisted pure laparoscopic living donor nephrectomy.

CONCLUSIONS

In this IDEAL stage2a study of 40 cases with camera holder, SSPLDN is technically feasible and safe.

ACKNOWLEDGEMENTS

This work was supported by a grant from the Asan Institute for Life Sciences, Seoul, Korea [grant number 2018-0864].

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KOREAN ABSTRACTS

서론: 생체 신 공여자들은 자신들의 건강을 위해 수술을 받는 것이 아니기 때문에 안전한 수술을 받는 것이 중요하다. 이는 생체 공여 신 절제술에서 최소 침습 술기의 발달을 가져왔다. 복강경 수술 중 안정적인 수술을 위해서는 집도의에게 카메라를 통해 보여지는 수술 시야가 안정적으로 유지되어야 한다. 카메라 홀더는 집도의가 의도하는 수술 시야를 흔들림 없이 안정적으로 제공할 수 있다. 이러한 카메라 홀더를 이용하여 수술 간호사 외에 다른 수술 인력 없이 집도의가 혼자서 시행하는 수술을 단독 수술이라고 정의한다. 단독 술자 순수 복강경 생체 공여 신 절제술의 수행 가능성과 안전성을 평가하기 위하여 우리는 IDEAL stage 2a study 를 설계하였다.

연구 재료 및 연구 방법: 이 연구의 프로토콜은 서울아산병원의 임상연구심의위원회가 승인하였고 (#2018-0864), 대한민국 질병관리본부 임상연구정보서비스에 등록되었다 (#KCT0003458). 선정 기준과 제외 기준에 합당한 대상자들을 본 임상 연구에 등록하고 단독 술자 순수 복강경 생체 공여 신 절제술을 시행하였다. 전체 대상자에 대하여 별다른 어려움 없이 단독 술자 순수 복강경 생체 공여 신 절제술을 시행한대상자의 비율로 수행 가능성을 평가하였고 수술 중/후 합병증을 확인하여 안전성을 평가하였다.

결과: 2018 년 11 월부터 2019 년 8 월까지 47 명의 잠재적 지원자 중에서 40 명을 본 임상 연구에 등록하였고, 참여 거부 의사를 밝힌 7 명을 제외하였다. 수행 가능성은 100% (40/40)으로 확인되었다. 10 명의 대상자에서 14 건의 경미한 수술 중 합병증이 발생하였고 34 명의 대상자에서 73 건의 경미한 수술 후 합병증이 발생하였다. 중대한 수술 중/후 합병증은 발생하지 않았다. 상기 합병증들은 모두 단독 수술과의 관련성이 없었다. 평균 전체 수술 시간은 175.6 ± 27.8 분이었고, 가장 길었던 전체 수술 시간은 235 분이었다.

결론: 단독 술자 순수 복강경 생체 공여 신 절제술은 기술적으로 수행 가능하고 안전하다.