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Experience of Cadaver Donor Nephrectomy with Cadaver Surgical Training

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ABSTRACT

As cadaver donor nephrectomy in kidney transplantation is performed in only a limited number of cases, few physicians are skilled in the surgical technique. We performed two cadaver donor nephrectomy sessions during cadaver surgical training. The first session was performed by a lecturer who was skilled in the technique, with physicians and nurses participating in order to learn the methodology. The second session was conducted only for physicians. The procedures undertaken were as follows: cannulation of the femoral artery and vein, skin incision and bowel ligation, cross-clamping of the aorta, diaphragmatic incision and inferior vena cava incision, dissection of the aorta and inferior vena cava, and nephrectomy. Although there were some differences from that normally observed in actual patient surgery, such as no bleeding and formalin fixation, some of the procedures were very useful in helping to better understand cadaver donor nephrectomy.

Key words anatomy; cadaver; surgery

In recent years, the number of cadaver donor nephrectomy (CDN) procedures performed after cardiac arrest for the purpose of kidney transplantation in Japan has remained around several dozen cases per year.[1] In 2020, only 9 cases under cardiac arrest CDN were performed in Japan.[1] Due to the limited number of cases, there is only a limited number of physicians who have CDN experience. Therefore, this makes it difficult to conduct any on the job training, with CDN training having to use animals such as pigs in order to obtain firsthand experience with the methodology.[2] Although animal-based training is very useful, it can be problematic due to the anatomical differences between the animals and humans. On the other hand, cadaver surgical training (CST) can also be problematic due to the lack of blood flow and formalin fixation, although it does allow for training procedures that are more in line with the actual surgical techniques. As a result, CST in Japan has been rapidly spreading over the past few years, with 138 cases being conducted in 2019.[3] At our institution, CST facilities were established in 2019. In this current report, we describe our experience with CDN performed during two different CST sessions.

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Abbreviations: CDN, cadaver donor nephrectomy; CST, cadaver surgical training

MATERIALS AND METHODS

This study was approved by the Tottori University Ethics Committee (no. 20F003). In the first session, we performed CDN on a male cadaver and invited a lecturer who was skilled in the technique to teach physicians, with 10 nurses also participating as observers. In the second session, we performed CDN on a female cadaver without a lecturer. In these two sessions, we used two cadavers that had been fixed by the Thiel's embalming method.[4–6] The procedures undertaken were as follows: cannulation of the femoral artery and vein, skin incision and bowel ligation, cross-clamping of the aorta, diaphragmatic incision and inferior vena cava incision, dissection of the aorta and inferior vena cava, and nephrectomy. The procedures were performed in accordance with the manual for cadaver donor nephrectomy prepared by the Japan Society for Transplantation.[7]

RESULTS

The time required for the first and second sessions is shown in Table 1.

Cannulation of the femoral artery and vein

After performing a 5 cm transverse incision in the inguinal area, the central and peripheral femoral artery and vein were secured. Each was dissected approximately 3 cm cephalad and then arterially blocked with Satinsky forceps. Following an angiotomy performed with a scalpel, a catheter was inserted. The veins were also catheterized and ligated using the same method (Fig. 1A).

Table 1. Time required for each step

	First session	Second session
Cannulation of the femoral artery and vein	8 minutes and 50 seconds	5 minutes and 40 seconds
Skin incision and bowel ligation	17 minutes and 50 seconds	19 minutes and 30 seconds
Cross-clamping of the aorta	7 minutes and 30 seconds	8 minutes and 20 seconds
Diaphragmatic incision and inferior vena cava incision	5 minutes and 30 seconds	3 minutes and 30 seconds
Dissection of the aorta and inferior vena cava	32minutes and 40 seconds	29 minutes and 10 seconds
Nephrectomy	4 minutes and 20 seconds	4 minutes and 30 seconds

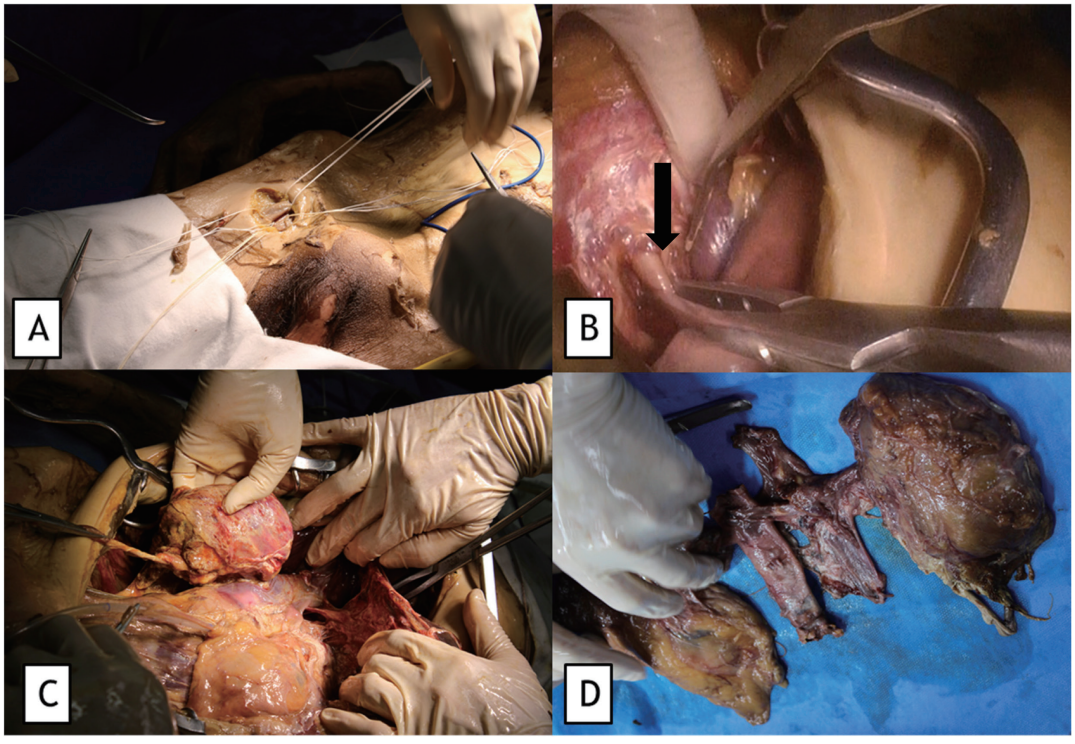

Fig. 1. Picture **A** shows catheter placement in the right inguinal region. The femoral artery and femoral vein are respectively secured with silk thread. Picture **B** shows a cross-clamp. The aorta is identified and clamped on the lateral side of the esophagus. The arrow indicates the clamped aorta. Picture **C** shows before nephrectomy and picture **D** shows the removed kidney. The left and right kidneys were removed along with the aorta and inferior vena cava. All pictures were provided by the Center for Education and Training in Clinical Anatomy, Tottori University School of Medicine.

Skin incision and bowel ligation

A skin incision was performed from the fenestrae to above the pubis. The incision was made into the peritoneal cavity near the umbilicus, taking care to avoid bowel injury. After confirming the condition of the intestine, the small intestine was moved cephalad. The peritoneum was cut up from the ileum to the ligament of Treitz and the aorta was exposed. The ureter was recognized and secured. An infusion catheter was placed over the common iliac artery, with the assumption there was no infusion catheter in place.

Cross-clamping of the aorta

The aorta was identified laterally in the esophagus through a lesser omentum incision. The aorta was secured with vascular tape and then cross-clamped. As in the urological field this is an unfamiliar technique, this required additional time in order to identify the aorta (Fig. 1B).

Diaphragmatic incision and inferior vena cava incision

The diaphragm was incised and the inferior vena cava was transected in the chest cavity. This procedure was

performed to prevent perfusion fluid from flowing into the peritoneal cavity.

Dissection of the aorta and inferior vena cava

After expansion of the retroperitoneal cavity on the right side, the duodenum was transferred allowing for exposure of the inferior vena cava. On the left side, after exposing the aorta, the superior mesenteric and celiac arteries were dissected.

Nephrectomy

At the bifurcation of the common iliac artery, the aorta and inferior vena cava were clamped, with the two paired arteries cut and each catheter then removed The aorta and inferior vena cava were separated at the line where the anterior longitudinal ligament was exposed and after lifting the pair, the kidney was subsequently removed (Figs. 1C and D).

DISCUSSION

The donor nephrectomy procedures for living and cadaver kidney transplantation are completely different. Living donor nephrectomies are often performed laparoscopically. In the case of cadaver kidney transplantation, both kidneys are removed under an open surgery, making the procedure very different from a standard nephrectomy. The ischemia time is longer and renal damage associated with ischemia may occur, so it is necessary to perfuse and remove promptly.

In the current training sessions, we performed CST of CDN. It should be noted that there was no bleeding observed, which is quite different from the actual situation. Furthermore, due to fixation by the Thiel's embalming method, it was difficult to identify the tissues such as the ureter and the greater omentum. As mentioned above, cannulation of the femoral artery and vein, cross-clamping of the aorta, diaphragmatic incision and inferior vena cava incision are procedures that are not usually performed or seen in urological surgery. One advantage of CST is that nurses and other co-medical staff can also participate. Anatomical structures were shared by reviewing them after the first session and giving a lecture before the second session. This allowed the physicians and nurses to become proficient in their roles, procedures, and use of surgical equipment. This is applicable for surgeries that normally only have a few cases, as this training makes it possible for physicians to review the procedure and help deepen their understanding of the overall technique. Due to the anatomical similarities with human, domestic pigs are usually used for surgical training for kidney transplantation.[8] However, considering that experiments on large animals can only be performed at limited facilities, this makes it difficult to frequently perform these procedures. On the other hand, CST can be performed regularly several times a year. In this CST, the second session was performed while confirming the procedure, anatomy, and surgical equipment to be used without a lecturer. Once a participant became experienced with the procedure, it could be performed in about the same amount of time as a skilled physician. In addition, further technique proficiency and time reduction may be expected with more frequent CSTs. In conclusion, CST training proved to be very useful in helping to understand the CDN technique.

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The authors declare no conflict of interest.

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