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Laparoscopic Nephrectomy for Massive Kidneys in Polycystic Kidney Disease

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ABSTRACT

Background and Objectives: Laparoscopic nephrectomy is now considered a feasible surgical approach, even for large kidneys. In the case of massive kidneys, laparoscopy can be problematic, so that some authors suggest an open approach. However, previous studies have shown that hand-assisted laparoscopic nephrectomy (HALN) may represent a useful compromise.

We describe our hand-assisted laparoscopic technique for nephrectomy of large kidneys (> 2500 g) to encourage the use of laparoscopy for nephrectomy in autosomal dominant polycystic kidney disease.

Methods: We retrospectively analyzed data from 26 nephrectomies in 17 patients who underwent HALN for ADPKD and compared them to a group of 22 nephrectomies in 18 patients with open surgical technique.

Results: The duration of the procedure was significantly longer in the laparoscopic group, with a median of 180 minutes versus 90 minutes for the unilateral nephrectomies, and 240 minutes versus 122 minutes for the bilateral procedures. The median kidney weight in the open group was 2500 g (range 1300 – 4500 g), while the median weight in the HALN group was 2375 g (range 1000 – 4700 g). The median hospital stay was comparable. No significant differences were recorded in the intra- and postoperative complication rate.

Conclusion: Hand-assisted laparoscopic nephrectomy can be considered a technique of choice for patients suffering from ADPKD requiring nephrectomy, also with massive kidneys weighing more than 3500 g. Compared to open nephrectomy, HALN can be performed safely, with reasonably longer operating times and without major complications, and offers a significant reduction in hospitalization time, pain and postoperative discomfort.

Key Words: Autosomal dominant polycystic Kidney disease (ADPKD), Laparoscopic nephrectomy, Hand-assisted laparoscopic nephrectomy, Polycystic kidneys, Bilateral nephrectomy.

INTRODUCTION

Autosomal dominant polycystic kidney disease (ADPKD) is the fourth most frequent cause (accounting for approximately 10%) of chronic renal failure,[1] manifesting as a progressive replacement of the renal parenchyma with cysts containing citrine liquid, which gradually increase in volume with the simultaneous reduction of renal function. The disease originates from a mutation of the ADPKD-1 or ADPKD-2 genes, which cause the syndrome by altering the synthesis of polycystin-1 and 2 proteins.[2]

Substitutive treatment, either dialysis or transplant, is generally necessary in 50% of cases up to the age of 60.[3–5] Patients with ADPKD frequently have other manifestations of the disease, such as hepatic, splenic, and pulmonary cysts,[6,7] and aneurysms of the circle of Willis (Berry aneurysms), which represent the cause of sudden death in 8–11% of cases.[8]

Enlarged kidneys can cause abdominal distension or pain, nausea, back pain, gastro-esophageal reflux syndrome, hypertension, but also serious complications such as hematuria, intracystic hemorrhage, cyst rupture, or even severe infections. Nephrectomy is reserved for symptomatic cases, counting for around 20%, and is generally postponed as long as possible in the case of kidneys still producing urine, to avoid the deterioration in terms of

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quality of life typical of dialysis patients who are completely anuric.

Infections can cause intracystic abscesses or potentially lethal sepsis in immunosuppressed transplanted patients. Antibiotics that can be used after transplantation generally do not penetrate the cysts and hence render post-transplantation treatment difficult and dangerous,[9] making preemptive nephrectomy recommendable. Furthermore, the kidneys may be of such a large volume that renal transplantation is difficult or even impossible due to the lack of space in the iliac fossae. The mass effect that makes renal transplantation impossible is thus a further indication for nephrectomy: whereas times and indications are not universally accepted, it has been demonstrated that nephrectomy before transplantation improves post-transplant graft and patient survival.[10]

Open nephrectomy is generally performed through a long xiphopubic or subcostal incision and can cause major complications, not least often severe postoperative pain. On the contrary, laparoscopic nephrectomy is today considered a feasible surgical approach, even for large kidneys, with better results in terms of complications, use of blood transfusions, postoperative pain and length of hospitalization.[9,11,12] The lower need for transfusions is especially useful in patients listed for a renal transplant, in whom the passive immunization originating from blood transfusions can reduce the chances of finding a compatible HLA donor.[13,14]

Since the first laparoscopic nephrectomy of a polycystic kidney reported in 1996 by Elashry et al,[15] many centers have used different laparoscopic techniques, demonstrating its feasibility.[16–18] Recently, several studies comparing laparoscopic nephrectomy with open nephrectomy for ADPKD have reported controversial results.[11,19–21]

The advantages of the laparoscopic approach are now well known in terms of reduction of the duration of hospitalization, reduction of morbidity, and faster recovery.[18] Furthermore, when performed as a combined procedure with a renal transplant, the laparoscopic approach offers a similar rate of morbidity to renal transplantation alone.[22] In the case of enormous kidneys, which often occupy the entire abdominal cavity and extend deep under the liver, laparoscopy can be very problematic and risky, prompting some authors to suggest an open approach.[23] However, previous studies[11] have shown that hand-assisted laparoscopic nephrectomy (HALN) can represent a useful compromise and be considered a better technique than open surgery for the removal of large polycystic kidneys.

In this paper we propose our hand-assisted laparoscopic technique for the nephrectomy of large kidneys (> 2500 g) and seek to define the criteria according to which an open approach might be advisable from the beginning.

MATERIALS AND METHODS

We retrospectively analyzed data from 26 nephrectomies in 17 patients who underwent HALN for ADPKD after 2015, and compared them to a group of 22 nephrectomies in 18 patients performed before 2015 using the open technique. Patient demographics, age, body mass index (BMI), and gender data were collected, together with the indications for nephrectomy and any history of previous abdominal surgery. This was in addition to intraoperative and postoperative data, which included unilateral versus bilateral nephrectomy, weight of kidneys removed, operative time, intra- and postoperative complications, need for transfusions and length of hospital stay. The two patients in whom a conversion to an open procedure was necessary were included in the HALN group for data analysis. Due to the retrospective nature of this study a selection bias is obviously possible.

Data Analysis

The statistical analysis was performed separately for unilateral and bilateral nephrectomies to better compare operative times, complications, need for transfusions, and length of hospital stay. Continuous variables were summarized as median values and compared using the Mann-Whitney test. Categorical variables were analyzed by X^2 or Fisher's exact test. $P < .05$ was considered statistically significant. The statistical analysis was conducted using the IBM SPSS Statistics 20 program.

Laparoscopic Hand-assisted Technique

All patients underwent preoperative imaging using CT or MRI with contrast medium (**Figure 1**).

The patient, under general anesthesia, is placed in a supine position and fixed to the operating table with two surgical table safety straps to allow rotation, with a lumbar support that is moved to the contralateral position for the second nephrectomy in the case of bilateral nephrectomy. Generally we prefer to remove the right kidney first in the case of bilateral nephrectomy, due to the greater difficulty related to the isolation of the renal vein near the cava vein and to the separation of the superior pole from the adrenal gland. This

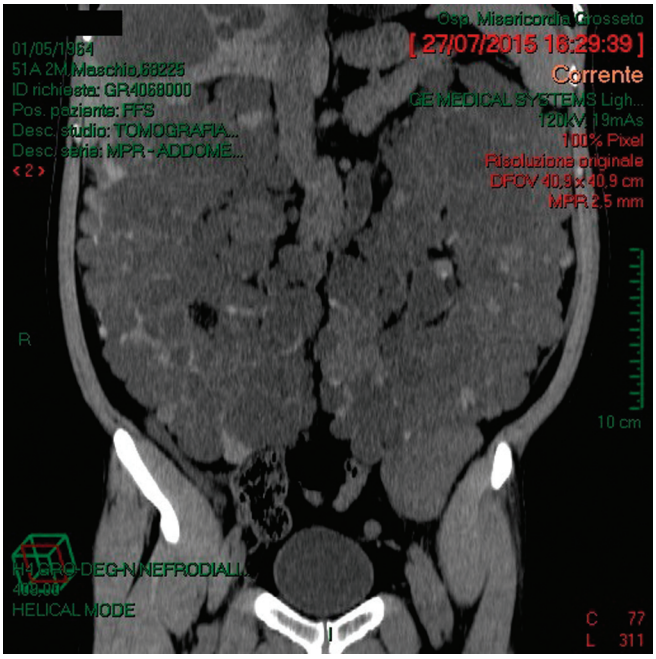

Figure 1. CT scan of massive polycystic kidneys (coronal view).

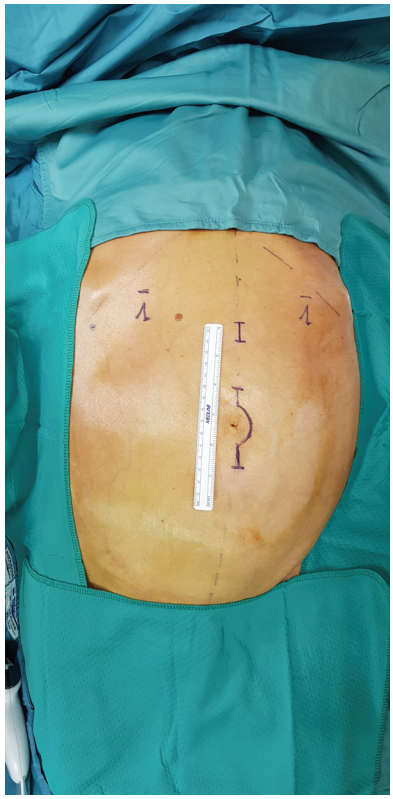

Figure 2. Supra- and subumbilical incision.

maneuver could cause bleeding, such as to recommend the interruption of the procedure to reduce the trauma for the patient, and postponement of the second nephrectomy to a later time.

A nasogastric tube and urinary catheter are put in place. The first step is a 7-cm supra- and subumbilical incision (**Figure 2**) on which a GelPort (Applied Medical Co., Rancho Santa Margarita, CA) is placed. Pneumoperitoneum is induced by a 12-mm trocar inserted through the GelPort before its placement (**Figure 3**). We consider the use of the GelPort to introduce one or more trocars very helpful as it saves further incisions, with a better cosmetic result and less trauma to the abdominal wall.

The 10-mm 30°F angled optic is introduced through the trocar, positioned through the GelPort, and the abdominal cavity is explored. The other trocars are positioned under direct vision to prevent damage to the abdominal organs. The definitive 12-mm optical trocar is positioned in the epigastrium, in the middle of the xiphoid umbilical line, and is used as the optic for nephrectomy on both sides. A 5-mm operator trocar is placed in the right hypochondrium for right nephrectomy and symmetrically in the left hypochondrium for the left. A further 5-mm trocar for the hepatic retractor is placed through the GelPort or, if necessary, in the epigastrium. The operator's forearm is covered with a sterile adhesive drape for waterproofing purposes, and the introduction of the hand is made easier by the use of liquid paraffin. We suggest the insertion of large laparotomic gauze through the GelPort that is used by the operator's hand. The pneumoperitoneum is able to grant enough space to isolate even large kidneys and allow safe access to the hilar structures also with the presence of large gauze into the abdominal cavity.

The table is rotated 30° towards the opposite side to that of the nephrectomy to allow the intestinal loops to fall due to gravity. Then, the right paracolic gutter was detached using ultrasound scissors and the Kocker maneuver to mobilize the duodenum was performed, to visualize the vena cava and the renal hilum. The ureter is isolated and dissected between Hem-O-Lok clips at the crossing with the common iliac vessels, and the superior pole of the kidney was then separated from the adrenal gland.

Particular attention is paid to trying not to break open the often infected renal cysts. In cases of extreme necessity, the content of the cysts is sucked into a dedicated aspirator, to be able to measure the weight of the liquid together with the weight of the organ, to calculate the new dry

Figure 3. Pneumoperitoneum induction by a 12-mm trocar inserted through the GelPort.

weight for hemodialysis after nephrectomy. Once the renal vessels at the hilum have been isolated with loops, we proceed to their division by means of an articulated mechanical stapler with a vascular load introduced through a 12-mm trocar inserted through the GelPort (**Figure 4**). This position permits the renal vessels to be approached perpendicularly, with minimal flexion of the articulated tip of the stapler.

Once the kidney is completely freed, an ileal bag is inserted through the GelPort and the surgical specimen is introduced into the ileal bag, not without some difficulty. This can be challenging but it is extremely necessary to isolate the kidney to be able to aspirate the cysts and reduce their volume without spilling the liquid into the peritoneal cavity. Dispersion of the liquid, in addition to carrying a risk of infection, would prevent exact calculation of the dry weight reduction, which is necessary for subsequent hemodialysis in pretransplant procedures.

Once the kidney was introduced into the bag, the cysts were opened with the scissors and the suction device used to empty the largest possible number of cysts, so that extraction can be performed through the small incision of 6–7 cm already used (**Figure 5**). We do not believe that the morcellation procedures recommended by other authors are appropriate, as they prevent analysis of the frequent small and newly formed nodules of the parenchyma.

For left nephrectomy the lumbar support is moved to the left. The optic remains in the same 12-mm epigastric trocar in the midline position. The 5-mm operator trocar is introduced through a symmetrical position in the left hypochondrium. For the left-handed or ambidextrous surgeon this position is optimal, whereas for the right-handed surgeon placement of the 5-mm trocar in the left iliac fossa can be taken into consideration.

Using the GelPort allows the simultaneous insertion of a 12-mm or 5-mm trocar, in addition to the operator's hand, thus reducing the number of breaches of the abdominal wall, with better cosmetic results, less postoperative pain, and a lower risk of developing future incisional hernias.

Finally, once the kidney has been placed into the ileal bag and the cysts have been aspirated, we proceed with extraction of the organ.

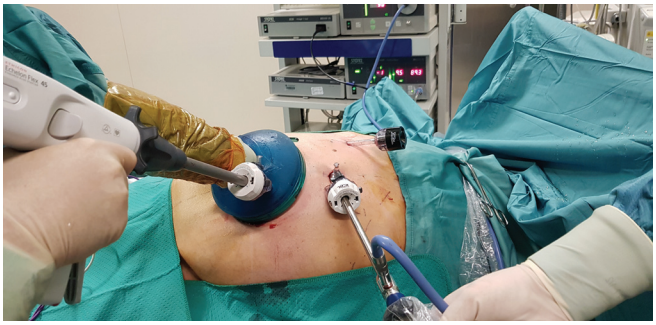

Figure 4. Section of the renal vessels with a mechanical stapler introduced through the GelPort.

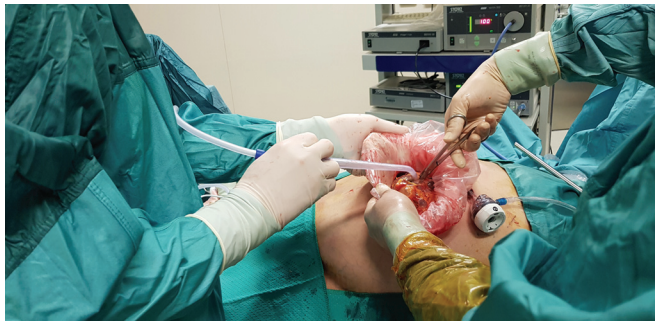

Figure 5. Aspiration of the cysts into the ileal bag, to reduce the kidney volume.

Two 15 Fr drains are placed in the two renal lodges, through 5-mm incisions of the trocars in the hypochondrium, to evacuate any lymph collections.

RESULTS

We identified 34 patients who underwent 48 nephrectomies for ADPKD either before or after renal transplantation. Demographics and indications for nephrectomy are shown in Table 1. We compared two groups: 18 patients (9 males) with a median age of 520.5 years (38 – 67 years) treated with single or bilateral open nephrectomy and 17 patients (9 males) with a median age of 54 years (35 – 63 years) who underwent hand-assisted (HALN) single or bilateral nephrectomy. In the open group 4 patients had a bilateral nephrectomy (22 kidneys removed in total) versus 9 patients in the HALN group (26 kidneys removed in total). Nine patients in the open group underwent a nephrectomy prerenal transplant, 9 post-transplant. Similarly, in the HALN group 9 patients underwent surgery before transplantation, 8 afterwards. The indications for surgery in both groups were mainly the mass effect, causing compression symptoms, followed by the presence of recurrent infections. Only in 1 case per group was intracystic or retroperitoneal bleeding the reason for the nephrectomy (**Table 1**).

Table 1.
Demographics and Indications for the Procedure of HALN Versus Open Nephrectomy

	HALN (n = 17)	Open (n = 18)
Median age, years (range)	54 (35 – 63)	53.2 (38 – 67)
Male gender (%)	9 (52.9%)	9 (50%)
Median BMI (range)	24.7 (18.6 – 35.1)	24.4 (20.9 – 27.3)
Indications • Size • Atypical cysts • Bleeding • Infections • Pain	100151	101160
Previous abdominal surgery	64.7% (11/17)	66.6% (12/18)
Bilateral nephrectomy	9	4
Unilateral nephrectomy • Right • Left	835	1477
Surgery before transplant	41.1% (7/17)	44.4 % (8/18)

The duration of the procedure was significantly longer in the laparoscopic group, with a median of 180 minutes (range 105–285) versus 90 minutes (range 60 – 135) in the open group for the unilateral nephrectomies, and 240 minutes (range 125–285) versus 122 minutes (range 105 – 150) in the open group for the bilateral procedures. The total mean kidney weight was 2713 g, considering both groups. The median kidney weight in the open group was 2500 g (range 1300 – 4500 g), whereas the median weight in the HALN group was 2375 g (range 1000 – 4700 g). The median hospital stay was comparable: 7 days (range 4 – 12) in the HALN group versus 7 days (range 4 – 13) in the open group (**Table 2**).

In two cases in the HALN group conversion to an open procedure was necessary: one due to the impossibility of safely reaching the upper pole of a massive left kidney (4700 g), which was strongly attached to the posterior structures; the other due to the rupture of a purulent cyst of the liver with consequent bleeding, which required conversion to achieve a thorough peritoneal toilet. The most frequent intra- and postoperative complications in HALN were bleeding (5 patients), followed by infections (3 patients). Two bleeding episodes occurred in the open versus 3 in the HALN group. Two patients in the HALN group required intra- or postoperative transfusions of leukodepleted red blood cells (2 and 4 units, respectively), while 3 patients in the open group were transfused (with 5, 3, and 2 units, respectively). There was one major postoperative complication in the open group: one patient developed an untreatable pulmonary infection and died from septic shock in the intensive therapy unit on postoperative day 4. One patient in the HALN group was readmitted to hospital 21 days after surgery (10 days after discharge) due to septic shock that required intensive therapy unit care. No other complications were recorded (**Table 3**).

We also analyzed a subgroup of patients with massive kidneys (at least one kidney weighing > 3500 g) in the HALN group, which consisted of 7 kidneys (5 patients), whereas we did not find any differences among the smaller kidneys in any of the parameters examined (**Table 4**).

Six of the 48 removed kidneys (120.5%) showed papillary microadenomas at pathologic examination.

DISCUSSION

Since the publication of the first case of laparoscopic nephrectomy of a polycystic kidney by Elashry et al in 1996[15], and since the first case of hand-assisted

Table 2.
Comparison of HALN Versus Open Unilateral and Bilateral Nephrectomy

	Unilateral Nephrectomy			Bilateral Nephrectomy		
	HALN (n = 8)	**Open (n = 14)**	***P* Value**	**HALN (n = 9)**	**Open (n = 4)**	***P* Value**
Median age, years (range)	54 (35 – 63)	55 (38 – 67)	0.815	54 (39 – 61)	52 (50 – 54)	0.503
Male gender (%)	4 (50%)	6 (42.8%)	0.779	5 (55.5%)	3 (75%)	0.979
BMI	23.8 (18.6 – 35.1)	24.4 (20.9 – 27.3)	0.714	24.6 (19.8 – 29.3)	25.5 (22.4 – 27.2)	0.503
Conversion to open	2	/	/	0	/	/
Previous abdominal surgery	6	8	0.649	5	1	0.559
No. of complications (%)	2 (25%)	2 (14.2%)	0.602	3 (33.3%)	2 (50%)	0.881
No. of complications ≥ Clavien-Dindo 3 (%)	1 (12.5%)	1 (7.1%)	0.879	1 (11.1%)	0	1.000
Median specimen weight, g (range)	2350 (1271 – 4700)	2500 (1300 – 4000)	0.910	2375 (1000 – 4500)	3450 (2000 – 4500)	0.261
Median length of stay, days (range)	8 (4 – 12)	7 (4 – 13)	0.212	6 (5 – 7)	9 (5 – 9)	0.106
Median operative time, min (range)	180 (105 – 270)	90 (60 – 135)	< 0.05	240 (125 – 285)	122 (105 – 150)	< 0.05
Blood transfusions (No. of patients)	1	1	0.879	1	2	0.203

laparoscopic nephrectomy reported by Schmidlin et al in 2000[24], the laparoscopic technique, with different variants and different approaches, has become common at least in centers with greater volumes of cases.[9] Already in 2001 Gill et al[18] published their first ten cases of full-laparoscopic bilateral nephrectomy, whereas in the same year Rehman et al[16] and in the following year Jenkins et al[17] described the hand-assisted technique for the first time. In 2004 Lee and Clayman[25] published a series of 7 hand-assisted laparoscopic nephrectomies using a very similar technique, if not the same, as that used today. Nowadays many centers carry out this procedure routinely.

In 2008 Binsaleh et al[26] described 16 laparoscopic nephrectomies with extraction of the intact organ (relatively small in size) through a subsequent median or Pfannenstiel incision. Also in 2008 Desai et al[27] described their hand-assisted technique, involving a median umbilical-pubic incision for GelPort positioning, then extension cranially by 2–3 cm for specimen extraction and partial reclosure to continue with the contralateral nephrectomy.

In 2012 Martin et al[22] reported 37 hand-assisted bilateral laparoscopic nephrectomies with excellent results. The authors suggest proceeding with bilateral laparoscopic nephrectomy simultaneously to transplantation, demonstrating a morbidity rate comparable to that of transplantation alone and the greatest benefit for the patient, who undergoes only one surgical procedure. The technique described by Martin et al[22] involves the introduction of the assistant's hand to retract the kidney, while the first operator maneuvers two laparoscopic instruments. In our technique we prefer the operator to introduce his/her hand through the GelPort, because we believe the sensitivity of fingers can be of great help in dissecting the cysts without causing their rupture and the release of the often infected fluid into the peritoneal cavity. The assistant, instead, has a free hand to retract the liver with a laparoscopic retractor (during a right nephrectomy) or to use suction.

In the same year Verhoest et al[21] compared 21 bilateral full-laparoscopic nephrectomies with 19 open ones. The full-laparoscopic technique involved a Pfannenstiel incision at the end of the procedure for the extraction of the surgical specimen, if necessary sectioned into parts. We do not consider it a good option to section the kidney or open the cysts while in the peritoneal cavity, due to their often infected content, which can potentially cause prolonged postoperative ileus or peritonitis-like syndrome.[27] Although the incidence of neoplasms on polycystic kidneys is the same as that in the general population,[28] we do not consider it correct to perform the morcellation of the surgical specimen as suggested by some authors[29] due to the risk, albeit low, of neoplastic dissemination and

Table 3.
Complications in the HALN and Open Group

	Hand-assisted Laparoscopic Nephrectomy						
Patient	Age	Gender	BMI	Indication for Nephrectomy	Side	Complication	Clavien-Dindo Grade
1	36	F	34.1	Infection	Right	Blood transfusion for postoperative anemia	II
2	39	M	24.6	Mass	Bilateral	Blood transfusion for postoperative anemia	II
3	55	M	19.3	Infection	Right	Chest drain for CVC related pneumothorax	IIIa
4	61	F	23.3	Mass	Bilateral	Revision of AV fistula	IIIa
5	54	M	29.3	Mass	Bilateral	Postoperative pancreatitis	I
6	59	F	19.8	Mass	Bilateral	Septic shock	IVa

	Open Nephrectomy						
Patient	Age	Gender	BMI	Indication for Nephrectomy	Side	Complication	Clavien-Dindo Grade
1	54	F	27.2	Infection	Bilateral	Blood transfusion for preoperative and postoperative anemia.	II/II
2	59	F	25.3	Infection	Left	Blood transfusion for postoperative anemia/death by postoperative pneumonia in ICU	II/V
3	52	M	25.4	Mass	Bilateral	Blood transfusion for postoperative anemia	II
4	46	M	24.6	Bleeding	Right	Blood transfusion for preoperative anemia	II

above all due to the impossibility of performing correct histological examination.

However, in the case of massive polycystic kidneys, the need for a large final incision to extract the intact specimen compromises the aesthetic result. In these cases it is preferable, in our opinion, to proceed immediately with such an incision and use a hand-port for the hand-assisted procedure (HALN). Crowding of the operating field caused by the hand reported by some authors[22] has never created any obstacle in our cases, perhaps due to the fact that the hand of the operator, rather than that of the assistant, is used in our technique.

To date, several studies on laparoscopic nephrectomy of polycystic kidneys have been published, and all agree that the technique is easy to perform and safe. All the authors have reported shorter hospitalization periods, and less morbidity and reduced complications. The transperitoneal access is generally considered easier, due to the larger space it offers.[21]

At our institution we generally prefer to perform bilateral nephrectomies, unless the patient still has preserved diuresis. In these cases we proceeded with a unilateral nephrectomy to create space in one of the iliac fossae in view of a transplant, or with the removal of the symptomatic kidney in the case of pain, hemorrhage, or pyelonephritis. However, we agree with other authors[9] that there are clear indications for bilateral nephrectomy, given that persistent and intractable pain is often bilateral, that recurrent pyelonephritis is extremely dangerous once immunosuppressive therapy is undertaken following transplantation and that hematuria from intra-cystic bleeding is difficult to locate. The monolateral nephrectomy of large kidneys also negatively affects posture, often creating more severe pain syndromes.[2]

Eng et al[11] reported a sizeable series of hand-assisted laparoscopic nephrectomies (58 cases of which 34 were bilateral) in 2013, suggesting the deliberate intraperitoneal rupture and aspiration of cysts for volume reduction. The authors, in contrast to the experience reported by Desai et al[27] did not detect any case of paralytic ileus (peritonitis-like syndrome) or wound infection. However, none of

Table 4.
Perioperative Outcomes for Patients With or Without at Least One Massive Kidney (Weight ≥ 3500 g)

	Hand-assisted Laparoscopic Nephrectomies		
	Massive Kidneys (at least one ≥ 3500 g) (n = 5 patients)	**Smaller Size Kidneys (n = 12 patients)**	***P* Value**
Median age, years (range)	53 (39 – 61)	54 (35 – 63)	0.879
Male gender (%)	3 (60%)	6 (50%)	0.817
BMI	24.6 (19.8 – 25.4)	24.7 (18.6 – 35.1)	0.721
Conversion to open	1	1	/
Unilateral/bilateral	1/4	7/5	/
No. of complications ≥ Clavien-Dindo grade 3 (no. of patients)	2	1	0.191
Median length of stay, days (range)	6 (5 – 7)	7 (4 – 12)	0.195
Median operative time, minutes (range)			
Unilateral nephrectomies	195	180 (105 – 270)	0.500
Bilateral nephrectomies	220 (195 – 285)	260 (125 – 272)	1.000
Blood transfusions (No. of patients)	1	1	0.515

these cases can be considered as "massive," as the kidney volume was never greater than 2500 ml.

In 2014 Williamson et al[30] published an interesting review of the literature, including analysis of many of the series published up to then, covering a total of 293 patients who had undergone a laparoscopic nephrectomy. The conclusion of the review, however, is that the quality of the studies included is poor, hence it is difficult to decide in favor or against a change in surgical technique and in clinical practice based on level 3 or 4 evidence, and that superior quality studies are required to demonstrate that the technique can be generalized. Although we agree with Williamson's conclusions, we believe that it is nowadays not feasible to conduct clinical studies involving the randomization of patients with an open or laparoscopic procedure, but that in the era of mini-invasive surgery a consensus should probably be sought based on well-conducted retrospective studies or on expert opinion, even if they only constitute level 4 evidence.

A further review of the literature made in 2015 by Guo et al[31] analyzes six papers containing seven studies with a total of 195 patients undergoing nephrectomy for ADPKD: 118 laparoscopic and 77 open. The analysis conducted confirms that the laparoscopic approach is feasible, safe, and effective, with significantly reduced morbidity compared to the open approach, also for symptomatic large kidneys. However, none of the papers examined in the review specifically analyzed massive kidneys.

Only the 2015 study published by Wiesenbaugh et al[9] from the Mayo Clinic (Phoenix, Arizona) examines 25 cases of bilateral laparoscopic nephrectomy of large polycystic kidneys (> 2500 g), which to our knowledge is currently the most substantial series published regarding "massive kidneys." The technique described, unlike ours, is essentially full-laparoscopic, although an infraumbilical GelPort is used to place trocars with hand protection. The surgical specimen is also removed through the infraumbilical incision without bagging it. The authors' conclusions are that no increase in the complication rate was found with the increased kidney size. In addition, 6 cases of kidneys larger than 3500 g were evaluated, showing results similar to the smaller ones.

Our case series similarly contained nearly 50% of kidneys weighing over 2500 g in the HALN group, and 7 kidneys over 3500 g. The duration of surgery was significantly longer using the laparoscopic technique, whereas the average hospitalization length was shorter, even if only slightly. The patients, many of whom were coming from distant places, were discharged once the bowel was open to normal stool and the need for pain killers had ceased. We recorded a shorter hospitalization time in bilateral nephrectomies, but the small number of cases did not reach statistical significance. We found no difference in intraoperative blood loss

and consequently in the need for transfusions. We did not register any complications related to the surgical technique that were higher than grade 2 in the Clavien-Dindo classification. Two cases were converted to an open procedure: due to the accidental rupture of a purulent liver cyst with consequent bleeding in one case, and to very difficult access to the upper pole of a left kidney, strongly attached to the posterior structures, in the other case. No differences were recorded in the separate analysis of the 7 massive kidneys removed using the laparoscopic technique in comparison with the others. Despite the lack of objective clinical data on patient preference (an index of patient comfort was not previously maintained for the control group operated on using the open technique), we are in favor of the laparoscopic technique, which represents the gold standard for nephrectomy in general. With the evolution of technology and the experience gained in recent years by many centers, we can no longer agree with the affirmation of Lipke et al[23] who, in 2007, suggested the direct open approach for patients with polycystic kidneys of an estimated size greater than 3500 ml. Although we are aware of the higher conversion risk in proportion to an increase in kidney size, we believe that an upper dimensional limit cannot easily be defined. We cannot generalize by indicating a maximum size or weight for which one technique or the other is to be recommended. We believe that precise preoperative study by CT or MRI may favor the open approach in the case of tenacious adhesions to important vascular structures, or in the presence of numerous small cysts, which makes their effective emptying and therefore the extraction of the specimen through a small incision almost impossible, thus compromising the minimally invasive procedure.

Hand-assisted laparoscopic nephrectomy can be considered a technique of choice for patients suffering from adult polycystic disease requiring nephrectomy, also with kidneys heavier than 3500 g. Compared to open nephrectomy, HALN can be performed safely, with reasonably longer operating times and without major complications, whereas offering a significant reduction in hospitalization time, pain, and postoperative discomfort. The extremely large size of the kidneys in our study was not associated with an increase in the complication rate even in the case of bilateral nephrectomy, which therefore does not represent a contraindication to the hand-assisted approach. In the case of kidneys smaller than 2000 g, full-laparoscopic nephrectomy, with kidney morcellation and its extraction through a 12-mm port is a valid option, but the impossibility of achieving correct histological evaluation must be considered seriously.

Regarding the ease of execution and the reduced invasiveness of the hand-assisted technique, we believe this is the technique of choice for all cases of large polycystic kidney disease as, in our opinion, a full-laparoscopic procedure followed by an incision of several centimeters for the extraction of the intact specimen can be considered a contradiction.

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