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Three-dimensional versus two-dimensional laparoscopic pyeloplasty in adults: a two-center comparative study.

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Dear Editor,

Clinical application of laparoscopy in the treatment of ureteropelvic junction obstruction (UPJO) started in 1993, when Schussler introduced laparoscopic pyeloplasty (LP) showing to reduce hospital stay with success rates equivalent to those of the open procedure [1].

Despite this, laparoscopy has some technical limitations, related to the poor depth of perception in the two-dimensional (2D) imaging system, rigid instruments, and the longer learning curve.

With the advent of robotic surgery, three-dimensional (3D) vision, and articulated instruments, this learning curve has been facilitated with an onerous economic burden for the healthcare system [2-3].

In this context, 3D laparoscopy has been proposed as a hybrid alternative bridging the limits of the conventional imaging system, in a cost-effective setting.

In the light of this, we retrospectively analyzed two-centers cohort outcomes for 3D-LP vs conventional LP between March 2012 to December 2019. UPJO was diagnosed by clinical symptoms and Tc-99m mercaptoacetyltriglycine renal scans. Consecutive men and women aged 18–76 years-old were eligible for inclusion if they had symptoms such as flank pain, progressive hydronephrosis, or renal functional deterioration and underwent surgery. Redo procedures, as well as any condition associated (i.e. double district, ectopic kidney, urolithiasis), were excluded from the analysis. The whole cohort was divided according to the imaging system available in each center: conventional 2D or 3D group. Each group underwent surgery by a single high-volume surgeon and two assistants, chosen in rotation from the urological equip. Open pyeloplasty was no longer performed during the inclusion period, whereas a robotic platform was present in one centre but reserved for oncological procedures. All patients underwent dismembered LP according the Anderson–Hynes template [4]; in case of 3D laparoscopy, the Endoeye Flex 3d® Olympus imaging system was used. Intraoperative and postoperative features were recorded, whereas complications were classified according to Clavien-Dindo classification [5]. Follow-up was based on a standard

shared protocol that consisted of a scheduled re-evaluation with a renal scintigraphy scan six months after surgery.

Descriptive statistics were used to verify the similarity between the 2-centre cohorts in terms of socio-demographic and pre-operative variables. Statistical significance for the tests was set at $\alpha < 0.05$. A one-way Kolmogorov–Smirnov statistical test was applied to assess the normality of variables; numerical variables were compared using t.test where normality could be assumed while categorical variables were tested applying Fisher-Freeman-Halton Exact test for sparse data.

Overall, 66 patients were included in the analysis. Baseline characteristics of the study groups are shown in Table 1; no statistical differences were found regarding age, sex, laterality and etiology.

Patients presented for flank pain in 71% of cases (32 cases in the 2D group, 15 in the 3D group), for pyelonephritis in 12% (5 in the 2D group, 3 in the 3D group), and in the remaining 17% without ~~a~~ symptomatology reported (incidental finding, 8 subjects in 2D group and 3 in 3D Group).

A ureteral double-J stent was placed at the beginning of each surgical procedure and maintained for an overall mean time (SD) of 41.5 days (1.94) with no significant difference among groups (41.4±2.1 vs 41.9±1.7; $p>0.05$); two cases each in the 2D and 3D groups were pre-stented. Single abdominal drainage was placed in all cases and removed after a mean time (SD) of 46.9 (4.7) hours in group A and 44.7 (3.9) hours in group B, respectively ($p>0.05$); while overall mean (SD) indwelling urinary catheter time was 5.3 (0.6) days after surgery (5.3±0.7 vs 5.2±0.4; $p>0.05$).

Among groups, no difference in terms of complications was recorded. As major complication, a case of intestinal perforation (Grade IIIb) and one of ureteral stent dislocation with subsequent repositioning (Grade IIIa) has been recorded in the 2D group. ~~An~~ One urinoma-related pyelonephritis and a case of urinary sepsis has been recorded as grade II complication, whereas no adverse event of a higher degree has been reported in the 3D group.

Of interest, Group 3D showed a significantly lower operative time, 120 minutes compared with 229 minutes of 2D cohort ($p<0.005$), with a comparable mean hospital stay duration (4.04 vs 3.9 days,

respectively; p=0.762) and the same median value (4 days; IQR: 94-96 vs 85-96 hours, respectively).

The mean (range) follow-up was 10.6 (6-67) months. The scintigraphic percentage variation values obtained were positive in the majority of cases, respectively 82% in the 2D cohort and 95% in the Group 3D; equal to zero in 11% and 5%, respectively, and negative in a 5% of cases from the 2D cohort.

The mean (SD) scintigraphic percentage improvement after surgery was +4.85% (0.049) for the 2D group and +7.36% (0.042) for the 3D group; a statistically significant difference ($p<0.005$).

Three small cohort studies compared 2D and 3D laparoscopic systems during pyeloplasty procedure (Table 2) [6,8]. Abou-Haidar compared 27 paediatric cases (2D = 19 patients, 3D = 8 patients) with UPJO who underwent LP with a significant decrease of mean operative time of 48 minutes, with no impact on complication rate and length of hospital stay [6]. In addition to this, Patankar and Padasalagi performed a randomized study 3D laparoscopy in an urological setting; in particular, 40 LP (2D = 19 patients; 3D = 21 patients) were included in the analysis showing significant advantages in terms of operative time ($P < 0.0003$), blood loss ($P < 0.028$), dissection, suturing and stenting time ($P < 0.0001$) [7]. Of interest, 3D system showed a lower emotional, physical, and cognitive stress experienced by the surgeon during each operative procedure [7]. Similarly, in a cohort of 31 cases (Group 3D = 16; Group 2D = 15) Xu et al. confirmed a reduced operative time with no difference regarding estimated blood loss, complications and hospital stay [8].

In a recent systematic review and meta-analysis, Light et al. showed that robot-assisted LP had a significantly higher success rate than LP (fixed-effects model OR 2.76, 95% CI 1.30 to 5.88; P=0.008) underlining the poor quality and heterogeneity of studies analyzed [9].

If, on the one hand, it is difficult to believe that robotic techniques are characterized by shorter operating time than laparoscopy considering docking times, on the other the 3D laparoscopy exceeds in a cost-effective way the problems related to the depth perception of 2D systems.

Available evidence should be appreciated in the context of respective chronological stages that occur within a typical evolution cycle of surgical innovation. It could be assumed that, for reasons related to the learning curves as for single-port robotic surgery, it would take several years before having data on the real potential of this new technology [10].

Our study is not devoid of limitations, of which the retrospective fashion is probably the most relevant. Moreover, pyeloplasty was performed by two different surgical teams. However, having the surgeons of the two groups worked together previously for many years and completed their laparoscopic learning curve using the ~~exact~~ same surgical intervention template, we believe it is safe to assume that this limitation was minimal in this study. In addition to this, even if 3D laparoscopy is already a well-known hybrid alternative bridging the limits of the conventional imaging system in a cost-effective setting if compared with the robotic platform, further data are required for the cost analysis for a wider diffusion of 3D setting worldwide.

In conclusion, LP is an effective treatment option for patients with UPJO with a low complication rate. Compared to conventional laparoscopy, 3D imaging system provides better clinical and surgical outcomes. Higher quality evidence from prospective observational studies and clinical trials is required.

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Table 1. Characteristics of patients by study group. SD: standard deviation; RF: renal function.

	Group 2D (45)	Group 3D (21)	P value
Gender, male/female	15/ 30	6/ 15	0.70
Age, years, mean (SD)	39.5 (±15.4)	42.9 (±14.2)	0.38
Laterality,			0.22
Right (%)	25 (55.5)	15 (71.4)	
Left (%)	20 (44.5)	6 (28.6)	
Etiology,			0.43
Congenital (%)	22 (48.9)	13 (61.9)	
Acquired (%)	23 (51.1)	8 (38.1)	
Complications (Clavien/Dindo scale)			1
1 (%)	3 (6.7)	2 (9.5)	
2	5 (11.1)	2 (9.5)	
3a	1 (2.2)	0 (0)	
3b	1 (2.2)	0 (0)	
Preop. RF (%±SD)	40±0.106	45±0.087	
Postop. RF improvement (%±SD)	4.85±0.049	7.36±0.042	<0.005

Table 2. Three-dimensional versus two-dimensional laparoscopic pyeloplasty: review of the literature.

Author (year)	Study design	No. of partecipants		Mean Age (years)		Main results
		2D	3D	2D	3D	
Patankar et al. (2017) [7]	Randomized	19	21	MD		The total operative time, blood loss, dissection, suturing and stenting time, and the surgeon-related anxiety in favor of 3D laparoscopy
Abou-Haidar et al. (2016) [6]	Retrospective	19	8	8	7	Lower Operative time per case for 3D cohort
Xu et al. (2014) [8]	Retrospective	47	38	54.6	54.8	Shorter operative time for 3D group
Present study	Retrospective	45	21	39.5	42.9	Shorter operative time and great functional improvement for 3D laparoscopy

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