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Comparison of the Clinical Outcomes of 2D, 3D Laparoscopic and Robot Assisted Pyeloplasty- A Propensity Score Matched Single Centre Experience

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Abstract

Objective: To assess the clinical and patient reported outcomes of laparoscopic pyeloplasty (2D/3D) and Robotic assisted laparoscopic pyeloplasty in patients with UPJO.

Materials and Methods: A propensity score matched single centre study conducted with 90 adult patients undergoing dismembered Anderson-Hynes pyeloplasty by a single surgeon between January 2016 and December 2020. The patients were divided into three groups- Group A 2D laparoscopic pyeloplasty (2DLP), Group B 3D laparoscopic pyeloplasty (3DLP) and Group C robot assisted laparoscopic Pyeloplasty (RALP), which were compared for patient demographics, operative time, hospital stay, perioperative complications, blood loss, duration of surgery, outcome, pain score and surgeon fatigue index (SFI).

Results: Patient's demographic data and co-morbidities were comparable in all three groups. The mean suturing time/mean total operating time in our study was 47/90 minutes for Group A, 42/81 minutes for Group B and 25/68 minutes for Group C and the p-value was statistically significant ($p<0.0001$). The mean blood loss, intra-op and post-op complications, mean pain score, success rate and was comparable in all groups. SFI was statistically significant in RALP ($p<0.0001$).

Conclusion: All the three modalities of pyeloplasty are equally effective in treating pelvic PUJO with comparable patient-reported outcomes at 3-month and 1 year follow-up. However, RALP merits over 2D/3D LP with lesser mean operative time, mean suturing time along with better surgeon fatigue index (SFI) score.

Keywords: 2D 3D laparoscopic pyeloplasty, hydronephrosis, laparoscopic pyeloplasty, robotic pyeloplasty, robotic assisted pyeloplasty, ureteropelvic junction obstruction (UPJO)

Introduction

Ureteropelvic junction obstruction (UPJO) is one of the most common causes of hydronephrosis resulting from both congenital and acquired conditions,[1] with a incidence of 1 in 500 to 1 in 1000.[2] Open Pyeloplasty still remains the gold standard for the management of UPJO historically but in last two decades minimally invasive techniques have become increasingly popular, thanks to several benefits such as smaller incisions, shorter length of stay and reduced pain.[3] In 1993 Schuessler et al described the first laparoscopic pyeloplasty (LP) noting the perceived advantages and comparable results with reference to the open technique.[4]

Laparoscopic pyeloplasty (2D/3D LP) remains a technically demanding procedure requiring advanced intra-corporeal suturing skills. Laparoscopic techniques have several shortcomings like restricted movement, increased dexterity, ergonomic positioning, and long learning curve of the surgeon which are overcome with Robotic Assisted surgeries. Robotics system has the distinct advantage in terms of better instrument articulation, improved 3D visualization. The development and dissemination of robotic surgical tools, such as the da Vinci system (Intuitive Surgical, Inc., Sunnyvale, CA), have the potential to alter the way urologists approach complex laparoscopic reconstructive procedures. Proponents of da Vinci cite the device's 3-dimensional visualization, damping of tremor, and more sophisticated ergonomics and surgical tools with greater degrees of freedom than traditional laparoscopic instruments.[5]

Materials and Methods: Between January 2016 and December 2020, 90 patients with UPJ obstruction underwent pyeloplasty in our tertiary institute by a single senior clinical fellowship trained urologist (AK). UPJO was diagnosed on the basis of detailed history and appropriate imaging technique such as intravenous pyelogram, ultrasound or CT urography, and nuclear scans (DTPA). Data of 102 patients who underwent transperitoneal Anderson-Hynes dismembered pyeloplasty for UPJO were studied in our study, 12 patients were excluded due to abnormal anatomy, redo cases and cases with non Anderson – hynes technique or open technique. The patients were propensity score matched using age, sex, BMI and co-morbidities. They were divided into three groups: 2DLP (Group A; n = 30), 3DLP (Group B; n = 30), and RALP (Group C; n = 30). Patient's demographic data, preoperative, intraoperative and postoperative datawere recorded. The2D and 3D laparoscopy procedures were performed using Karl Storz (Tuttlingen, Germany) system and RALP by da-Vinci Xi (Intuitive Surgical, Inc., Sunnyvale, CA) system.

On the basis of the subjective feeling, the surgeon fatigue index (SFI) was calculated on the scale of 1-10. One way ANOVA was used to find the p-value. The total operative time (in minutes) was defined as time from pneumoperitoneum to end of skin closure. The suturing time was the time taken from first suture to the last knot. The success was defined as absence of symptoms and non obstructive drainage on DTPA scan at 3 month and 1 year.

Operative Procedure

Cystoscopy and ureteral catheter (6 French) placement and RGP (retrograde pyelography) under fluoroscopic guidance was done with the patient in the standard lithotomy position. The patient was repositioned into modified flank position. For all the techniques, pneumoperitoneum was established with Veress needle and standard port positions were used in all cases. The da Vinci Surgical System one extra assistant's port was placed. The colon was dissected and retracted medially and the ureter was identified, traced to the uretero-pelvic junction. The stenotic segment was excised as necessary (around 1-2 cm). The divided ureteral end was spatulated laterally for 1 cm. any pelvic secondary calculi, if present was removed. If an anterior crossing vessel is present, the renal pelvis was transposed anterior to the vessel and the posterior anastomosis performed with a running 4-0 polyglactin suture, 15 cms in length. Antegrade DJ stenting was done and the anterior anastomosis was completed with a second running suture. A reduction pyeloplasty was done if a redundant pelvis is present. A 12 Fr or 14 Fr drain was inserted through an 8-mm lateral trocar site. Drain was removed after 48 hours, if 24 hours drain output was less than 30 ml. Foley catheter was removed 24 hours after drain removal. The DJstent was removed in 4 weeks. All patients had undergone DTPA scan at 3 months.Follow-up appointments were scheduled at 1 week, 3 months and annually thereafter.

Results: Patients demographic data shows the mean age (in years) in Group A, B and C was 29.8, 32.2 and 31.4 respectively. The male to female patients in the groups were 18:12 (Group A), 19:11 (Group B), and 18:12 (Group C), respectively. The side was predominantly left in 66% (Group A), 60% (Group B), and 66% (Group C), respectively. The mean BMI (kg/m^2) was similar in the three groups- 22.16 (Group A), 21.19 (Group B), and 24.12 (Group C), respectively. There was no statistically difference in the patient demographic parameters.

The perioperative data showed that the crossing vessel was present in 24/90 cases: 8 (26.6%) in Group A, 7 (23.3%) in Group B and 9 (30%) in Group C. Furthermore, secondary calculi was present in 7/90 cases: 2 (6.6%) in Group A, 2 (6.6%) in Group B and 3 (10%) in Group C. The mean suturing time in our study was 47.3 ± 7.65 minutes for Group A, 42.23 ± 4.783 minutes for Group B and 25.2±4.13 minutes for Group C. The mean total operative time in our study was 90.93 ± 6.36 minutes for group A, 81.5 ± 11.18 minutes for group B and 68.83 ± 6.36 minutes for Group C respectively.

The mean blood (+ urine) loss in our study was 61.1 ± 12.5 ml for Group A, 47.67 ± 15.01 ml for Group B and 44± 16.4 ml for Group C respectively.The visual analog scale score (VAS) for pain on postoperative day 1 was 5.7 for Group A, 5.4 for Group B and 5.5 for Group C respectively. The duration of mean post-operative stay in our study was 3.1 ±1.3 days for Group A, 2.5 ±1.1 days for Group B and 2.3 ±1.3 days for Group C respectively.

Overall complications were seen in 12.2% of patients (11/ 90) - Group A, B and C had 16.6%, 10% and 10% respectivelywith no patient having Clavien-dindo grade III -V.

Surgeon fatigue index (SFI) was calculated which showed values of 7.447, 7.117 and 4.893 respectively clearly showing that 2D conventional laparoscopy was associated with maximum fatigue to the operating surgeon and RALP demonstrating least SFI due to ergonomics offered by the robot Failure rate was 5.6% overall (5/90) with individual groups showing 10%, 3.3% and 3.3% respectively. None of the patients required open conversion. The mean follow-up of the patients was 12.5 months (3-36 months). The success rate as per follow up DTPA scan at 3 months and 1 year ,was seen in overall 94.4 % of patients .The success rate was comparable in all 3 groups .

Discussion

The conventional laparoscopic camera includes a 2D system, and although high-resolution systems have improved the image quality substantially, there is still a lack of depth and spatial perception. This leads to increased learning curve as there is a need to interpret the secondary spatial cues such as shadow and motion parallax. The 3D systems eliminate the need to overcome the loss of stereoscopic vision and thus improving the surgeon's laparoscopic skills. Even though, 3D systems have improved a lot in terms of better ergonomics when compared to their predecessors, they are still plagued by certain shortcomings such as eye fatigue, motion blur and the need for special equipment increasing the cost involved in it.[6] The lesser difference seen in the study between 2D and 3DLP may be attributed to the fact that the senior surgeon (AK) had good expertise in laparoscopy.

The mean suturing time in our study was 47.3 ± 7.65 minutes for Group A, 42.23 ± 4.783 minutes for Group B and 25.2 ± 4.13 minutes for Group C which was less[7,8] than Gettman et al[10] and Link RE et al[11]. The mean suturing time between 2D and 3D was statistically significant (p=0.0032) favoring 3D LP. The da-Vinci scores over many short comings of the 2D/3D laparoscopy by providing 3D magnified image, damping of tremor, and more sophisticated ergonomics and surgical tools with greater degrees of freedom than traditional laparoscopic instruments. Multiple reviews and meta analysis have shown superiority of RALP vs 2D/3D LP.[7,8,9,10]

Various studies showed significant lesser total operative time between 2D/3DLP versus RALP[7,10,14,15] and the meta-analysis of operating time showed a 27-min shorter time for RAP vs 2DLP (P = 0.003).[9] The mean total operative time in our study for RALP was 68.83 ± 6.36 minutes compared to 109 ± 11.6 minutes[10] and 100.2 ± 9.1[11]. The reasons could be attributed to surgeon experience, exclusion of docking time and patient demographics. The p-values between 2D LP vs 3D LP (p<0.05), 2D LP vs RALP (p<0.001) and 3D LP vs RALP (p<0.001) were significant.

The mean total SFI was another significant factor in the study which favored RALP (SFI-4.89) vs 2D/3D LP with a p-value <0.0001, it was comparable to Rasool et al[12] who showed mean surgeon fatigue index (SFI) was 7 ± 1.1 in the LP group compared to 4.12 ± 1.1 in RALP group which was statistically significant (*p*< .001).[12] At our tertiary care centre the landscape of ureteropelvic junction obstruction treatment has changed dramatically with a paradigm shift from 2D to 3D laparoscopy and finally to RALP.

The limitations of the study were lesser number of patients, no randomization, no cost analysis and the single surgeon factor. The reason for not doing cost analysis is the said institute is government funded with no cost to the patient/ insurance. The VAS and SFI are subjective scores and bias is possible.

Conclusion:

RALP is a safe and feasible option for UPJO, with lesser total operating time, suturing time and SFI, in

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comparison to 2D/3D LP. More randomized studies with larger number of patients are required.

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Table 1 – Comparison of the three groups

Parameters	Group A 2DLP (n=30)	Group B 3DLP (n=30)	Group C RALP (n=30)	p-value
Crossing vessel (number/percentage)	8/26.6%	7/23.3%	9/30%	n/a
Secondary Calculi(n/Percentage)	2/6.6%	26.6%	3/10%	n/a
Mean BMI kg/m^2	22.16 ± 2.68	21.19 ± 2.72	24.12±3.48	p=0.3922
Mean total operative time (mins)	90.93±6.36	81.50±11.18	68.83±6.36	P<0.0001
Mean suturing time (mins)	47.3±7.65	42.23±4.78	25.2±4.13	P<0.0001
Mean Blood loss (ml)	61±12.5	47.67± 15.01	44± 16.4	P=0.04
Mean Pain score- VAS	5.7	5.4	5.5	P=0.2774
Mean Post op stay (days)	3.1	2.5	2.3	P=0.16
Complications (n/Percentage)	5/5.56%	3/10%	3/10%	n/a
Success (n/ percentage)	28/94.4%	29/ 96.7%	29/ 96.7%	n/a
Failure (n/Percentage)	2/6.6%	1/3.3%	1/3.3%	n/a
Mean SFI- Surgeon Fatigue Index	7.44 ±1.58	7.17 ± 1.43	4.89 ± 1.51	P<0.001

Table 2: Intraoperative comparison with one way ANOVA

	Mean Operative Time (mins)						
	Group A (2DLP)	Group B (3DLP)	Group C (RALP)	Differences in between the group			One-way ANOVA
Data size (n)	30	30	30	2D vs 3D	2D vs RALP	3D vs RALP	
Mean (mins)	90.93	81.50	68.83	P< 0.05	< 0.0001	< 0.0001	P < 0.0001
Standard deviation	6.36	11.18	6.36				
	Mean Suturing time (mins)						
Data size (n)	30	30	30				
Mean (mins)	47.30	42.23	25.20	0.0032	< 0.0001	< 0.0001	< 0.0001
Standard deviation	7.65	4.783	4.139				
	Mean SFI						

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Data size (n)	30	30	30	0.4912	< 0.0001	< 0.0001	< 0.0001
Mean	7.44	7.17	4.89				
Standard deviation	1.58	1.43	1.51				

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