Original Research Article

New Indian Journal of Surgery
Volume 9 Number 3, May - June 2018
DOI: https://dx.doi.org/10.21088/nijs.0976.4747.9318.1

Comparative Study of Laparoscopic Vs Open Pyeloplasty

Ajay Kumar[1], Deepak A. Dwivedi[2]

[1]Senior Resident [2]Assistant Professor, Dept. of Surgery, Base Hospital, Delhi Cantt, New Delhi, Delhi 110010, India.

How to cite this article:

Ajay Kumar, Deepak A. Dwivedi. Comparative Study of Laparoscopic Vs Open Pyeloplasty. New Indian J Surg. 2018;9(3):255-261.

Abstract

Background: Open pyeloplasty has been the gold standard for surgical treatment of PUJ obstruction. Over the last two decades the treatment approach to PUJ obstruction has evolved from open pyeloplasty to various minimally invasive procedures. Laparoscopic pyeloplasty has developed world wide as the first minimally invasive option to match success rate of open pyeloplasty

Method: The study was carried out in our tertiary care centre between 2012 to 2015. 50 adult patients of Primary PUJ Obstruction were included in the study who underwent either Open or Laparoscopic Pyeloplasty. Patient were followed up after 4-6 weeks of surgery and outcome of surgery compared.

Results: Laparoscopic pyeloplasty appears to be a safe and effective alternative to open pyeloplasty in adults. Laparoscopic Pyeloplasty has almost similar short term outcome if renal parameters are compared. A trend toward longer operating time but shorter hospital stay with the laparoscopic approach was noted, although at this point the evidence does not indicate either technique is better than the other.

Conclusions: Laparoscopic Pyeloplasty is a technically sound operation which uses well established principles familiar to urologist. This procedure has a minimal level of morbidity, short hospital stay, better cosmesis compared to open approach. Laparoscopic pyeloplasty has emerged as the standard of care and is here to stay.

Corresponding Author: Deepak A. Dwivedi, Assistant Professor, Dept. of Surgery, Base Hospital, Delhi Cantt, New Delhi, Delhi 110010, India.

E-mail: deepakfrcs@yahoo.co.in

Received on 22.02.2018, **Accepted on** 03.03.2018

Keywords: Laparoscopic; Open Pyeloplasty; Pelviureteric junction (PUJ).

Introduction

Pelviureteric junction (PUJ) obstruction is the most common congenital abnormality of the upper urinary tract. The surgical repair of PUJ obstruction was first recorded more than 100 years ago [1].

Open pyeloplasty has been the gold standard for surgical treatment of pelviureteric junction (PUJ) obstruction, enjoying a long-term success rate exceeding 90%[2]. This procedure requires a muscle incision that entails some degree of morbidity. PUJO causes hydronephrosis and progressive renal impairment may ensue if left uncorrected [3]. The optimum surgical correction of PUJO has been a urological challenge for over a century [4].

Open pyeloplasty originally described by Andersen and Hynes[1] remains the gold standard against which new technique must be compared. The morbidity associated with flank incision, however, has led to development of minimally invasive approaches to PUJO repair.

Over the last two decades the treatment approach to PUJ obstruction has evolved from open pyeloplasty to various minimally invasive procedures like endopyelotomy, acucise catheter incision, balloon dilatation and laparoscopic pyeloplasty. Endopyelotomy is not popular among urologists due to the success rate of these minimally invasive options has been less than with open pyeloplasty by 10–30% [5]. Comparing to open surgery and complications such as bleeding. It is usually performed using either antegrade or retrograde

approach. This method is not recommended in cases with long stricture, aberrant vessel, or hydronephrosis [6].

Trends toward less invasive surgeries have been increasingly considered. Since 1993, when the first laparoscopic pyeloplasty was performed, published reports have shown comparable results, complication rates, and recovery time with open pyeloplasty. Eventually, laparoscopic pyeloplasty is less invasive and more successful rate than endoscopic approach, mostly performed using dismembered or Y.V. plasty methods [7-8] Also, another method is Fengerplasty [9].

Laparoscopic pyeloplasty was described first in 1993 by Schuessler et al. Laparoscopic pyeloplasty has developed world wide as the first minimally invasive option to match success rate of open pyeloplasty.

In some studies Laparoscopic pyeloplasty is reportedly comparable and possibly superior to open pyeloplasty in adults. Its potential advantages including less postoperative pain, shorter hospital stay and improved cosmesis have been proved in previous comparative series. The duration and amount of analgesic requirement is significantly less than that in open pyeloplasty.

Although Laparoscopic pyeloplasty has the disadvantages of longer operative time and requires significant skill of intracorporeal knotting but it is here to stay and represents an emerging standard of care.

Material and Methods

Study Design

The study was carried out in our tertiary care centre between 2012 to 2013. 50 adult patients of Primary PUJ Obstruction were included in the study who underwent either Open or Laparoscopic Pyeloplasty depending upon surgeon's choice. Patient were followed up after 4-6 weeks of surgery and outcome of surgery compared.

Inclusion Criteria

1. Patients above 18 years of age
2. Patients of primary PUJ Obstruction

Exclusion Criteria

1. Patients of recurrent/ secondary PUJ Obstruction
2. Patients with urinary tract infection
3. General contraindications for laparoscopic surgery (e.g.morbid obesity, major bleeding disorders, unacceptable anaesthesia risks and patients who do not tolerate the pneumoperitorium).

Methodology

1. Detailed history including symptoms of pain/ fullness/discomfort and duration of symptoms recorded in each case.
2. Clinical examination includes general and systemic examination including abdomen and other systems examination.
3. Apart from routine investigations all patients underwent Renal USG, IVU and 99 mTc- DTPA scan/EC scan
4. All patients with primary PUJO underwent Anderson Hynes dismembered Pyeloplasty either Open or Laparoscopic depending on surgeon's choice.
5. All the patients were operated under general anaesthesia. A retrograde pyelogram was done in all the patients before the surgery to delineate PUJO and to rule out other associated anomalies such as VUR (vesico-ureteral reflux). The patients were catheterized and the catheter was left on free drainage during the operation. Intraoperation antibiotics were administered to minimize the risk of infections.
6. In Laparoscopic surgery the patients were put in the modified lateral decubitus position where patient was at 45 degree to the lateral position and were secured by placing a sand bag to support their backs, In Open surgery patients were positioned in lateral position.
7. Patient underwent either of the following procedure
   a. Anderson Hynes dismembered open pyeloplasty.
   b. Laparoscopic Anderson – Hynes pyeloplasty.
9. Post operatively
   a. The drain was removed in less than 5 CC/ 24 hrs
   b. The catheter was removed the next day
   c. Oral fluids and feeding were started at the appearance of peristaltic bowel sounds.
10. DJ stent was put in each patient which was removed after 4-6 weeks post surgery.
11. All the patients followed up after 4-6 weeks after surgery and history, clinical examination along with investigations in the form of Renal function test, USG (KUB) and DTPA scan carried out.
12. All data analyzed and comparison of both group done using T-test, Paired T-test and Chi square test. P value of <0.05 was considered significant.

Results and Observations

The present prospective study was conducted in Army Hospital Research and Referral, in Department of General Surgery and Department of Urology from July, 2012 to Dec, 2013 included 50 patients of primary PUJ obstruction.

1. *Patient selection:* Patients underwent Open or Laparoscopic Pyeloplasty depending on surgeons' choice. 30 patients underwent Open and 20 underwent Laparoscopic Pyeloplasty. Out of them 2 patients were converted to open due to non-progression of surgery due to dense adhesions. They were finally grouped in open group.
2. *Age group:* The mean age of the patient in Open group was 32.70(22-46) and in Laparoscopic group it was 31.45(24-45) with no significant difference, The study was in adult patient so no patients <18 years were selected (Table 1).
3. *Gender*: In all patients 78% were male and 22% were female with a ratio of 3.5:1 whereas literature says male predominance of more than 2:1.
4. *Native place*: Although literature does not show any geographical distribution of incidence of PUJ obstruction, but in our study 90% of the patient came from North India. This may be due to selection bias due to our institute is situated in Delhi.
5. *Side*: In our study 62% PUJ obstruction was on left side and 38% was on right side. This value corroborates with previous literature.
6. *Presenting symptoms*: Most of the patients presented with pain as primary symptom followed by flank lump whereas few of them presented with discomfort and fullness. Two patients were detected to have PUJ obstruction incidentally during routine USG abdomen for other medical ailments (Table 2).
7. *Co-morbid conditions*: 5 of the patients was hypertensive (3 in the open group and 2 in Laparoscopic group) All were well controlled with medication. One was obese and one had Bronchial asthma in open group. But these co-morbid condition had no significant impact on surgical outcome (Table 3).
8. *Renal functions*: Deranged renal functfion in the form of Creatinine>1.2 was found in 22% of the patient, rest 78% of the patient had normal level of creatinine.
9. *Dynamic Renal Scan*: (DTPA/EC scan) Mean GFR in open group was 64.12(54.34-76.55) and in Laparoscopic group was 62.75(54.65-70.56) and the split function mean in Open group was 34.16%(25-40%) and in Laparoscopic group was 35%(32-40%). T1/2 was not achieved in any case. All the patient with split function of less than 40% were taken for surgery.
10. *Duration of surgery*: There was significant difference in duration of surgery where Laparoscopic surgery took mean duration of 137.5min(110-180min) and Open surgery took mean duration of 108.67(85-155min). The difference was significant with p-value of <0.001.
11. Per/*Post op complications*: The per-op complication of Bleeding was almost equal in both the group but non of them required transfusion. But incidence of SSI was significantly more in open group and one of the reason of longer hospital stay.
12. *Duration of Hospital stay*: Hospital stay was also significantly lesser in patients who underwent Laparoscopic Pyeloplasty as compared to Open group. The mean hospital stay in open group was 7.93 (5-15) whereas in Laparoscopic group was 2.55 (2-7), p-value<0.001.
13. *Post-op symptoms improvement*: There was significant improvement in symptoms of patients post-

Table 1:

	Open Pyeloplasty, n=30		Laparoscopic Pyeloplasty, n=20		t-value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation		
Age	32.70	6.83	31.45	5.39	0.69	0.50

Table 2:

Symptoms	Open	Laparoscopic	Total
Pain	21	14	35
Lump	4	3	7
Discomfort	2	2	4
Fullness	2	0	2
Asymptomatic	1	1	2
Total	30	20	50

Table 3:

Co-morbidity	Open	Laparoscopic	Total
Nil	25	18	43
HTN	3	2	5
Obesity	1	0	1
Bronchial Asthma	1	0	1
Total	5	2	7

operatively in both the group but there was no significant difference in improvement when both the group are compared.

14. Post-op renal function and Dynamic renal scan: There were significant improvement in variables eg. Creatinine level, Hydronephrosis grade, GFR and split function in both the group separately but there was no significant difference when both the groups were compared for the improvement (Table 4 and 5).

Discussion

The first successful reconstruction of an obstructed PUJ was accomplished in 1892.The gold standard for the repair of PUJ obstruction is open pyeloplasty and the best clinical results have been reported with the complete dismembering techniques like the Anderson-Hynes procedure. The success rates of this technique are reported to be 90-100% [10].

Due to postoperative pain, longterm recovery, and long incision in open pyeloplasty, several less invasive methods have been proposed, including antegrade and retrograde endopyelotomy; nevertheless, their success rates are 10% to 30% lower comparing to open pyeloplasty, particularly when aberrant vessels, kidney function impairment, or severe hydronephrosis are present [11]. On the other hand, bleeding occurs in 3% to 11%, requiring blood transfusion [12].

The varied surgical anatomy of PUJ (huge dilatation, crossing vessels, high insertion of ureter) compromise all of these endourological procedures. These procedures are also associated with a risk of peri-operative hemorrhage and 3–11% patients' required blood transfusion [13-14].

Laparoscopic pyeloplasty provides a minimally invasive alternative to repair PUJO. Laparoscopic pyeloplasty was introduced in 1993 by Schussller et al. and has developedworld wide as the first minimally option to match success rate of open pyeloplasty [15].

Reconstruction of PUJO can be tailored to anatomical findings at the time of surgery [16]. The feasibility of Laparoscopic pyeloplasty including Anderson Hynes , fengers, Foleys VY plasty performed through transperitoneal and retroperitoneal approach has been evaluated [17]. Its potential advantages including less postoperative pain , shorter hospital stay an improved cosmesis have been proved in some comparative series [18-20]. The only disadvantage seems to be longer operative time in published series [18-19]. However, Zhang et al. [17] reported less operative time in Laparoscopic group (retroperitoneal) than open group.

As laparoscopic surgery becomes more entrenched in resident training, the more complex skills such as intracorporeal suturing becomes less daunting. Moreover, long operative times may be reduced by skill of intracorporeal knotting and development of new robotic equi pment [19].

The performance enhancing feature of da vinci robot seems to decrease the difficulty of intra corporeal suturing. In general the reported overall complications rate of laparoscopic pyeloplasty ranges from 4%–12.7% [17].

The results of laparoscopic pyeloplasty from several institutions which reported on the adult series, suggested that this procedure was a viable alternative to both open and endoscopic procedures. With the increased training and experience, the success rate has clearly exceeded that of endoscopic approaches and it is similar to that of open pyeloplasty. The potential advantages of laparoscopic pyeloplasty over open pyeloplasty are decreased post-operative pain, shorter hospitalization, short convalescence and improved cosmesis. An important caveat, as was concluded by Bauer et al. [21], is that neither open nor laparoscopic pyeloplasty can universallyguarantee complete pain relief. Laparoscopic pyeloplasty in children is even more technically challenging than that in adults because of the smaller operative space and the need for finer suture material [22].

Table 4: Open Pyeloplasty

Variables	N	Pre op		Post op		t-value	p-value
		Mean	Std. Deviation	Mean	Std. Deviation		
Creatinine	30	1.01	0.33	0.74	0.25	4.192	<0.001
HDN Gr	30	4.70	0.47	2.63	1.16	9.906	<0.001
DTPA(GFR)	30	64.13	6.02	73.61	6.57	7.211	<0.001
DTPA(% Function)	30	34.16	4.02	51.80	7.18	6.95	<0.001

Table 5: Laparoscopic Pyeloplasty

Variables	N	Pre op		Post op		t-value	p-value
		Mean	Std. Deviation	Mean	Std. Deviation		
Creatinine	20	1.015	0.33916	0.75	0.28928	3.251	0.004
HDN Gr	20	5	0	3.1	0.71818	11.831	<0.001
DTPA(GFR)	20	62.7465	5.52563	71.719	6.1215	5.609	<0.001
DTPA(% Function)	20	35.0	4.07043	49.95	4.40663	4.893	<0.001

However, laparoscopic pyeloplasty has been demonstrated to be feasible and to have satisfactory early results. After a decade, laparoscopic pyeloplasty has emerged as a durable elective technique for the management of PUJ obstruction. Laparoscopic pyeloplasty is continuing to progress and it offers promise for some of the most challenging circumstances. As the technology advances and as the clinical experience increases, this technique may universally replace open pyeloplasty as the gold standard [22]. In this study we compared the two most commonly performed surgery for PUJ Obstruction. In both laparoscopic and open group AH dismembered Pyeloplasty was done. The major findings of study were:

All the patients selected were more than 18 years of age. The mean age in Open group was 32.7 and in Laparoscopic group was 31.45. There was no sex difference in both the group. The incidence of PUJ obstruction in male was more with male to female ratio of 3.5:1. The patients were selected randomly so there was no age or sex variation. The incidence of PUJ obstruction is less defined in adults than in children [23]. It is decreasing in adults due to more early detection by antenatal USG. In one retrospective study, functionally significant PUJ obstruction was noted in 1 in 1500 fetuses screened by antenatal ultrasound [23]. Although literature does not show any geographical distribution of incidence of PUJ obstruction, but in our study 90% of the patient came from North India. This may be due to selection bias due to our institute is situated in Delhi.

The incidence of PUJ obstruction was more in left side than right side with a ratio of 1.6:1. Bauer SB et al found left kidney affected twice more than right side[24]. Bilateral involvement was found in 10-40% of cases[25]. In our study there was no patient with bilateral PUJ obstruction.

Most of the patients presented with pain in the flank followed by fullness, discomfort and lump. Other symptoms include vomiting, hematuria, urinary tract infection. The clinical presentation in particular the presence or absence of pain depends upon the site of obstruction, the degree of obstruction (i.e. partial or complete) and the rapidity with which obstruction develops [26]. In our study 70% of the patients presented with pain, 14% with lump, 8% with discomfort, 4% with fullness and 4% were asymptomatic.

Five of the patients were hypertensive (3 in the open group and 2 in Laparoscopic group) All were well controlled with medication. One was obese and one had Bronchial asthma in open group. But these co-morbid condition had no significant impact on surgical outcome. HTN. Renin-mediated hypertension can occur with unilateral renal obstruction and hydronephrosis. Elevated peripheral plasma renin activity and a lateralizing renal vein renin relationship represent a hormonal pattern suspiciously suggestive of a renovascular etiology. Riehle and Vaughan reported a case of surgically corrected renin-mediated hypertension secondary to ureteropelvic junction obstruction. Hyperreninemia associated with acute unilateral hydronephrosis probably occurs transiently to initiate chronic hypertension sustained by more complex volume-vasoconstriction abnormalities. The participation of renin in this hypertension seems to be influenced by the duration of the obstruction, the presence or absence of a contralateral normal kidney and other intrarenal factors [27].

Deranged renal function was taken as Creatinine >1.2mg/dl was present in 22% of the function and 78% patient had normal Creatinine level i.e. ≤ 1.2mg/dl. Madsen, H.T. et al. reported blood chemistry is normal with respect to Renal and Liver function in unilateral hydronephrosis [28]. In our study mean creatinine level was 1.01mg/dl and 22% of the patient had creatinine level >1.2mg/dl. Maximum level was 1.6mg/dl.

The very important finding was significant difference in duration of surgery where Laparoscopic surgery took mean duration of 137.5min(110-180min) and Open surgery took mean duration of 108.67 (85-155min). In a similar study done by Heidi A. Penn et al. Mean operative time was 151 minutes (range 94 to 213) for laparoscopy and 130 minutes (83 to 225) for open surgery. Ravish et al reported their experience in 29 patients with a mean operative time of 159 minutes in open pyeloplasty and 214 minutes in laparoscopic Pyeloplasty [29]. Laparoscopic surgery needs more expertise and definitely is more time consuming as observed in many series[18-19]. Zhang et al. reported less operative time in Laparoscopic than open pyeloplasty [17]. 2 patients undergoing Laparoscopic Pyeloplasty was converted to Open due to non-progression of surgery because of dense adhesion. In a similar study done by Srinivas KK et al. on 30 patients and another study done by Simforoosh et al on 69 patients there were no conversion of laparoscopic to open surgery. Eden CG et al reported conversion rate of 4% in study on 50 patients. In Soulie's study, 5.4% of cases required conversion to open surgery[20].In our study the conversion rate was 4%.

Per-op complication was mainly bleeding which was taken as significant if >500ml blood loss was there. There was no significant difference in both the group. None of the patient required transfusion. Most of the study quoted no transfusion required. In general the reported overall complications rate of laparoscopic pyeloplasty ranges from 4%–12.7%[17]. Most of the complications of laparoscopic pyeloplasty are similar to those of general laparoscopic procedures, including colonic injury, hemorrhage, ileus, pneumonia, congestive heart failure, thrombophlebitis, and urinoma formation. In the first 100 cases of laparoscopic pyeloplasty performed at Johns Hopkins Medical

Institutions (Jarrett et al., 2002), such complications occurred in 12% of the patients.

Surgical site infection was more in Open group and the difference was significant. It also contributed to longer hospital stay in Open group. This rate was comparable to any other abdominal surgery in our centre. The overall rate of SSI in any laparotomy not involving intestine is 1.9-6.9%[30]. George et al. stated that in their transperitoneal urological laparosopic surgery series there were 2.5% cases of SSI and body mass index and operative time were significant predictive factor for SSI occurrence [31]. In our study it was it was 13%(4 patients) in open group and 5% (1 patient) in laparoscopic group.

Hospital stay in Open group was significantly longer. The mean hospital stay in open group was 7.93(5-15) whereas in Laparoscopic group was 2.55(2-7), p-value <0.001. Heidi A. Penn et all reported mean hospitalization was 29.3 hours (range 20.5 to 48) for laparoscopy and 36.2 hours (24 to 73) for open surgery (p - 0.06)[71]. In a study by Bansal et al the post operative hospital stay in LP was mean 8.29 days (7–11) and was significantly less than open group (mean 3.14 Days (2–7 days)[27].

There was significant improvement in symptoms of patients post-operatively in both the group but there was no significant difference in improvement when both the group are compared. A study by Jarrett and colleagues showed decreased the degree of hydronephrosis in 96% of 100 patients undergone laparoscopic Pyeloplasty[32]. Adeyoju AB et al reported the success rate of laparoscopic Pyeloplasty to be consistently high, at 87–98%[33]. In our study the follow up period was less (4-6 weeks) therefore success rate cannot be commented upon.

There were significant improvement in variables eg. Creatinine level, Hydronephrosis grade, GFR and split function in both the group separately but there was no significant difference when both the groups were compared for the improvement.Soulie reported 88.5% and 89.3% success rate in laparoscopy and open pyeloplasty groups, respectively [20]. The success rate was defined by various studies in various ways. Most of them defined improvement in symptoms and improvement in function on dynamic renal scan.

Summary and Conclusions

Laparoscopic pyeloplasty appears to be a safe and effective alternative to open pyeloplasty in adults. Laparoscopic Pyeloplasty has almost similar short term outcome if Renal parameters are compared.

A trend toward longer operating time but shorter hospital stay with the laparoscopic approach was noted, although at this point the evidence does not indicate either techniqueis better than the other.

Laparoscopic Pyeloplasty is a technically sound operation which uses well established principles familiar to urologist. The only disadvantage of Laparoscopic pyeloplasty is longer operative time and requires significant skill of intracorporeal knotting. This procedure has a minimal level of morbidity, short hospital stay, better cosmesis compared to open approach.Laparoscopic pyeloplasty has emerged as the standard of care and is here to stay.

The results of laparoscopic pyeloplasty from several institutions which reported on the adult series suggested that this procedure was a viable alternative to both the open and endoscopic procedures. With the increased training and experience, its success rate has clearly exceeded that of endoscopic procedures and it is similar to that of open pyeloplasty. After a decade, laparoscopic Pyeloplasty has emerged as a durable elective technique for the management of PUJ obstruction. Laparoscopic pyeloplasty is continuing to progress and it offers promise for some of the most challenging circumstances. As the technology advances and as the clinical experience increases, this technique may universally replace open pyeloplasty as the gold standard.

These procedures are seemingly equivalent. Surgeon and family preference and esthetic issues may be the deciding factors.

References

1. Anderson JC and Hynes W. Retro-caval ureter: a case diagnosed preoperatively and treated successfully by a plastic operation. Br J Urol 1949;21:209.
2. Troxel S, Das S, Helfer E et al. Laparoscopy versus dorsal lumbotomy for ureteropelvic junction obstruction repair. J Urol. 2006;176:1073–6.
3. Persky L, Krause JR, Boltuch RL. Initial complications and late results in dismembered pyeloplasty. J Urol 1977;118:162–64.
4. Adeyoju AB, Hrouda D, Gill IS. Laparoscopic pyeloplasty: the first decade. BJU Int 2004;94:264–67.
5. Schuessler WW, Grune MT, Tecuanhuey LV et al. Laparoscopic dismembered pyeloplasty. J Urol 1993;150: 1795–99.
6. Chen RN, Moore RG, Kavoussi LR. Laparoscopic pyeloplasty. Indications, technique, and long-term outcome. UrolClin of North Am 1998 May;25(2):323-30.
7. Janetschek G, Peschel R, Bartsch G. Laparoscopic fengerplasty. J Endourol 2000 Dec;14(10):889-93.
8. Van Cangh PJ, Wilmart JF, Opsomer RJ, et al. Long term results and late recurrence after endouretero-pyelotomy: a critical analysis of prognostic factors. J Urol 1994;151:934-7.
9. Kletscher BA, Segura JW, LeRoy AJ, et al. Percutaneous antegrade endoscopic pyelotomy: review of 60 cases. J Urol 1995;153:701-3.

10. Notley RG, Beaurgie JM. The long term follow up of Anderson-Hynes pyeloplasty for HN. British Journal of Urology 1973;45:464-67.
11. Chen RN, Moore RG, Kavoussi LR. Laparoscopic pyeloplasty. Indications, technique, and long-term outcome. UrolClin of North Am 1998 May;25(2):323-30
12. Brooks JD, Kavoussi LR, Preminger GM, et al. Comparison of open and endourological approaches to the obstructed ureteropelvic Junction. Urology 1995 Dec; 46(6):791-5.
13. Badlani G, Eshghi M, Smith AD. Percutaneous surgery for ureteropelvic junction obstruction (endopyelotomy) technique and early results. J Urol 1986;135:26–29.
14. Brooks JD, Kavoussi LR, Preminger GM, Schuessler WW, Moore RG. Comparison of open and endourological approaches to obstructed ureteropelvic junction. Urology 1995;46:791.
15. Adeyoju AB, Hrouda D, Gill IS. Laparoscopic pyeloplasty: the first decade. BJU Int 2004;94:264–67.
16. Jarrett TW, Chan DY, Charambura TC, Fugita O, Kavoussi LR. Laparoscopic pyeloplasty; The first 100 cases. J Urol 2002;167:1253–56.
17. Zhang X, Li H-Z, Ma X et al. Retrospective comparison of Retroperitoneal laparoscopic versus open dismembered Pyeloplasty for ureteropelvic junction obstruction. J Urol 2006;176:1077–80.
18. Bonnard A, Fouquet V, Carrricaburu E et al. Retroperitoneal laparoscopic versus open pyeloplasty in children. J Urol 2005;173:1710–12.
19. Klingler HC, Remzi M, Janetschek G, et al. Comparison of open versus laparoscopic pyeloplasty techniques in treatment of uretero-pelvic junction obstruction. Eur Urol 2003;44:340-5.
20. Soulie M, Thoulouzan M, Seguin P et al. Retroperitoneal laparoscopic versus open pyeloplasty with a minimal incision: comparison of two surgical approaches. Urology 2001;57:443–47.
21. Bauer JJ, Bishoff JT, Moore RG, Chen RN, Iverson, et al. Laparoscopic versus open pyeloplasty: Assessment of objective and subjective outcome. Journal of Urology 1999;162(3-1):692-95.
22. Srinivas KK et al. Journal of Clinical and Diagnostic Research. 2011 December;5(8):1601-05.
23. Morin L, Cendron M, Crombleholme TM, et al. Minimal hydronephrosis in the fetus: clinical significance and implications for management. J Urol 1996;155:2047.
24. Bauer SB. Anomalies of the kidney and ureteropelvic junction. In: Walsh PW, Retik AB, Vaughan ED Jr, Wein AJ, editors. Campbell's Urology. 7th ed. Philadelphia: WB Saunders Company; 1998.pp.1739–49.
25. Koff, SA, Mutabagani, KH. Anomalies of the kidney. In: Adult and Pediatric Urology, 4th ed, Gillenwater, JY, Grayhack, JT, Howards, SS, Mitchell, ME (Eds), Lippincott Williams and Wilkins, Philadelphia, 2002. p.2129.
26. Frokiaer J, Zeidel M, Urinary Tract Obstruction In: Brenner and Rector's The Kidney, 9, Elsevier, New York 2011.
27. Bansal et al. Laparoscopic Versus Open Pyeloplasty: Comparison of Two Surgical Approaches- A Single Centre Experience of Three Years. Indian J Surg 2011 Jul-Aug;73(4):264–267.
28. Madsen, H.T., Larsen, F. and Hauge, P.: Bilateral giant hydroureteronephrosis: A case report with a review of the literature. Rontgenblatter., 1989;42:432-34.
29. Ravish IR, Nerli RB, Reddy MN et al: Laparoscopic pyeloplasty compared with open Pyeloplasty in children. J Endourol 2007;21:897.
30. CDC NNIS System. National Nosocomial Infections Surveillance (NNIS) report, data summary from October 1986- April 1998, Issued June 1998.
31. George, A.K., Srinivasan, A.K., Cho, J., Sadek, M.A., and Kavoussi, L.R. Surgical site infection rates following laparoscopic urological procedures, J. Urol. 2011;185:1289.
32. Jarrett et al. Jarrett TW, Chan DY, Charambura TC, et al: Laparoscopic pyeloplasty: The first 100 cases. J Urol 2002;167:1253.
33. Adeyoju AB, Hrouda D, Gill IS. Laparoscopic pyeloplasty: the first decade. BJU Int 2004;94:264–67.