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Dr. Punit Srivastava
Professor Pediatric Surgery, SN Medical College Agra, Uttar Pradesh, India

Dr. Richa Jaiman
Professor General Surgery, SN Medical College Agra, Uttar Pradesh, India

Dr. Deepak Kumar
Junior Resident, SN Medical College Agra, Uttar Pradesh, India

Corresponding Author:
Dr. Punit Srivastava
Professor Pediatric Surgery, SN Medical College Agra, Uttar Pradesh, India

Stent versus stentless pyeloplasty in congenital pelvic ureteric junction obstruction kidney in children

Dr. Punit Srivastava, Dr. Richa Jaiman and Dr. Deepak Kumar

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Abstract
Objective: The aim of this study was to compare between stenting and stentless dismembered pyeloplasty as regards outcome, early and late postoperative results, and complications.
Background: Ureteropelvic junction obstruction is a common congenital urologic anomaly. Open pyeloplasty is the standard surgical treatment. Drainage following pyeloplasty using a double J stent prevents subsequent stenosis and urine leakage.
Patients and Methods: This study was conducted on 50 pediatric patients (maximum age 16 years) with a primary diagnosis of ureteropelvic junction obstruction who were divided into two groups: Group 1, the stented group double J (25 cases). Group 2, the nonstented group (25 cases). Classic Anderson–Hynes pyeloplasty was performed for the two groups.
Results: A total of 50 patients were included in the study. 27 (54%) cases were male and 23 (46%) cases were female. Their ages ranged from 6 months to 15 years. The mean ± SD age was 6.75 ± 4.53 years. All cases were unilateral; 25 (50%) cases were right sided and 25 (50%) cases were left sided. Postoperative complications included the following: urinary tract infection in only one case in group 1, residual mild hydronephrosis in only one case in group 1 and three (30%) cases in group 2; clot formation in only one case in group 2, and urinoma in only one case in group 2.
Conclusion: Pyeloplasty with a diverting stent is technically feasible and safe. Only risks for multiple anesthesias and economic burden with stent removal are present. The specific indication when stented pyeloplasty needs to be performed is in redo pyeloplasty, solitary kidney, inflamed renal pelvis, and hugely distended renal pelvis.

Keywords: Postoperative results, stented pyeloplasty, ureteropelvic junction obstruction

Introduction

Pelviureteric junction obstruction (PUJO) or Ureteropelvi junction obstruction (UPJO) is the commonest cause of hydronephrosis in children. Once obstruction has been diagnosed the surgeons main priority is to decide whether the child requires an operation.

There are many controversies with respect to approach, degree of invasiveness and timing of surgery. The objective however is the same in all approaches: to preserve renal function in the least morbid manner with the best possible outcome.

Anderson-Hynes dismembered pyeloplasty has been used for more than 50 years and it remains the surgical treatment of choice for paediatric PUJO. Although there have been many modification the basic operative technique for dismembered pyeloplasty is universal, involving excision of the pelviureteric junction and redundant pelvis when necessary, and re-anastomosis of the healthy ureter to the renal pelvis [1].

The postoperative follow up of patients involves ultrasound and diuretic renal scan. This yields structural and functional assessment of the operated kidney. However since the success rates of pyeloplasty are as high as 97% it seems unnecessary to expose 100 children to ionizing radiation to find the 2 or 3 who might have postoperative obstruction. Postoperative follow up with ultrasound is being explored as a viable alternative with diuretic renal scan reserved for doubtful cases [2].

Aims and objectives

Aim

The Aim of this study is to study the stent versus stentless pyeloplasty in congenital pelviureteric junction obstruction.

Objectives

1. To see the effectiveness of stented pyeloplasty in congenital pelviureteric junction obstruction.
2. To see the effectiveness of stentless pyeloplasty in congenital pelviureteric junction obstruction.
3. To compare the effectiveness of two modalities in terms of-

- operative time
- hospital stay
- postoperative complications
- postoperative effect on hydronephrosis
- postoperative differential renal function (DRF).

Review of literature

Incidence

Pelviureteric junction (PUJ) obstruction is a chronic partial or intermittent obstruction due to an intrinsic defect in motility across the PUJ or extrinsic compression which impedes the passage of urine from the renal pelvis to the ureter.

PUJ obstruction (PUJO) is the commonest cause of foetal hydronephrosis with a reported incidence of about 1:750 to 1:1000 live births. PUJO is usually unilateral affecting the left side twice as commonly but may be bilateral in 10 to 15% of cases. In newborns, the male to female ratio is 2:1.

Etiopathogenesis

The causative factor for PUJO may be intrinsic, intramural or extrinsic

Intrinsic

Aperistaltic segment.

An aperistaltic segment at the PUJ impedes the flow of urine across it Figure 1(a). It is characterised by a poorly distensible segment of variable length which may be probe patent. The etiology remains unclear. Various factors like incomplete recanalisation of the ureter during development, abnormal innervation and disordered architecture of the muscle with abnormal collagen deposition have been hypothesized.

High insertion of the pelviureteric junction

The PUJ is inserted high on the pelvis and distension of the pelvis causes obstruction of the nondependent ureter.

Intra mural

Ureteric folds

The PUJ is normal and patent but the proximal ureter is tortuous and kinked. Figure 1(b). Straightening of these folds with growth may explain the resolution of PUJO observed in some antenatally detected cases.

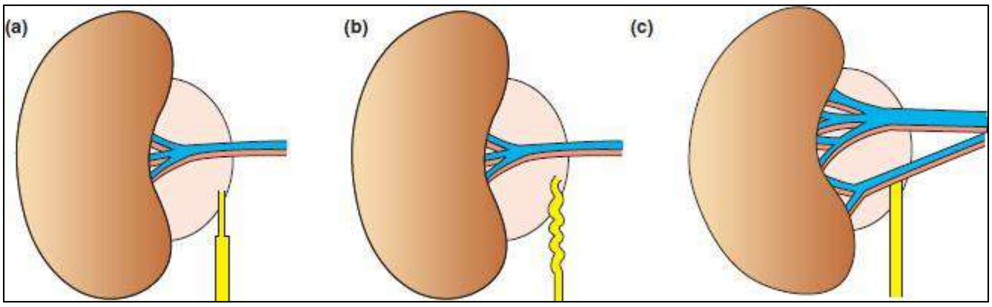
Ureteric polyps

These rare fibro epithelial polyps are usually seen in the mid ureter.

Extrinsic

Aberrant lower pole vessel

Crossing lower pole vessels causing kinking of the ureter account for about 30% of obstruction in older children. Figure 1(c).



(a) Intrinsic stenosis. (b) Ureteric folds. (c) Crossing lower pole vessel

Fig 1: Etiology of pelviureteric junction obstruction. (from Essentials of Paediatric Urology, 2nd Edition)

Other causes of PUJO

Retrocaval ureter

This is due to the abnormal development of the posterior cardinal veins within which the ureter is trapped and obstructed.

Horseshoe kidney

This is the most common complication of horse shoe kidney and may be due to compression of the ureter by an aberrant vessel or distortion as it passes over the distended isthmus Figure 1.d.

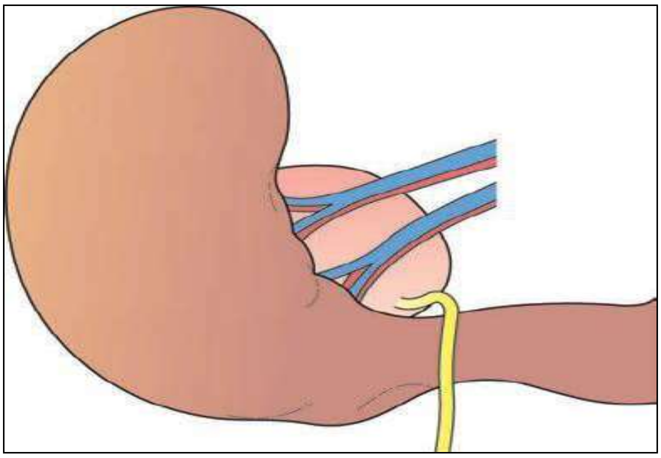


Fig 1 (d): Horseshoe kidney causing obstruction at the PUJ (from Essentials of Paediatric Urology, 2nd Edition)

Vesicoureteric reflux

Major grades of reflux cause tortuosity and kinking of the ureter leading to secondary PUJO.

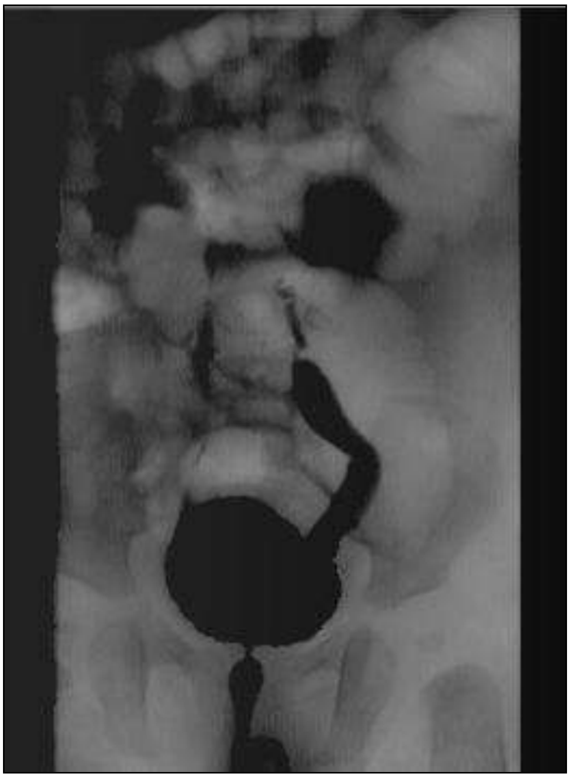


Fig 1 (e): MCU showing major reflux causing kinking at the PUJ

Presentation

With advances in foetal ultrasound screening and its widespread usage, antenatal detection has become the commonest mode of presentation.

In children who have not been identified by foetal ultrasound, flank pain is a common presenting complaint. Older children with a crossing vessel might present with intermittent pain with a palpable mass which is relieved with diuresis called Dietels crisis.

It is not uncommon for a child with PUJO to present with a urinary tract infection which, in some instances may progress to pyonephrosis.

A grossly hydronephrotic kidney may present with a palpable mass. Trivial trauma may cause hematuria. Occasionally the PUJO may be detected incidentally while evaluating the child for some unrelated symptom. Newborns with a massive hydronephrosis can rarely present with a urinoma at birth.

Diagnostic Evaluation

The wide spread use of antenatal ultrasound has helped identify many infants with hydronephrosis; all of whom may not have a functional obstruction requiring surgical intervention. The diagnostic armamentarium available needs to be used judiciously to establish the cause of hydronephrosis and determine the degree of obstruction.

Antenatal ultrasound

The routine use of prenatal ultrasound has lead to the early detection of hydronephrosis. This has shifted the patient profile from symptomatic older children to largely asymptomatic newborns.

A few concerns have emerged from the widespread use of prenatal ultrasound. Firstly, the lack of consensus regarding the definition of hydronephrosis. Secondly, the correct evaluation and management of asymptomatic hydronephrosis [3].

The Society for Foetal Urology (SFU) classification of foetal hydronephrosis (table 3.1) provides a guide to the prognosis and need for postnatal evaluation. Grades I and II will require a postnatal ultrasound to reassess the kidney and a MCU to rule out reflux. The higher grades require functional evaluation and will most likely require corrective surgery.

Table 1: SFU grading scale for hydronephrosis detected by US

Grade	Central renal complex (pelvis and calices)	Renal parenchyma
I	Slight splitting	Normal
II	Evident splitting; confined within renal border	Normal
III	Wide splitting; pelvis dilated outside renal border; calices dilated	Normal
IV	Wide splitting with pelvis dilated outside renal border; calices dilated and may appear convex	Atrophy

Bouzada *et al.* took into consideration the anteroposterior diameter (APD) after 28 weeks of gestation. They found that an APD ≥ 15mm has sensitivity of 82.4% and specificity of 87.9% to identify renal units that will require medical or surgical treatment [4].

Addressing the second issue of asymptomatic hydronephrosis, a meta analysis done by Lee *et al.* highlights the dilemma regarding the treatment of mild and moderate hydronephrosis which have a risk of pathology of 11.2% and 43.5% respectively(5). The global consensus is toward conservative management in asymptomatic infants less than 6 months of age [3]. Yi Yang *et al.* in their long tern follow up of antenatal hydronephrosis found that SFU grades I and II did not require surgical intervention. Greater improvement occurred in children with differential renal function less than 40% but it did not recover to predeterioration levels postoperatively. They recommended earlier intervention following a short period of strict surveillance for preservation of renal function [6]. Postnatal ultrasound has become a cornerstone in the evaluation of children with antenatal hydronephrosis. The recommended timing of the postnatal scan is between 4 to 7 days of life [7].

Ultrasound

Ultrasound is inexpensive and non-invasive, does not expose the child to ionizing radiation and is not limited by renal failure. This makes it an excellent tool for screening and follow-up. The size of the kidney, the cortical thickness and the anteroposterior diameter indicating the degree of dilation can be measured and compared with age appropriate normograms. It is however operator dependent, cannot diagnose obstruction and does not give any functional information. The quality of the scan can be limited by body habitus, excess bowel gas and lack of patient cooperation.

Fig 2: US measuring the AP diameter

Diuretic Renal scintigraphy (DRS)

Once the diagnosis of hydronephrosis is made, the next step is to establish function of the renal unit and the degree and level of obstruction. DRS is commonly used in the diagnosis and follow up of children with PUJO and for postoperative evaluation following pyeloplasty.

The radiopharmaceuticals used in DRS comprise a radionuclide (Technetium 99m), bound to a carrier macrolide. Technetium 99m-diethylenetriaminepentaacetic acid (99mTc-DTPA) and technetium 99m-mercaptoacetyltriglycine(99mTc-MAG-3) are currently the preferred radionuclides used in suspected PUJO. They are both preferentially concentrated by the kidney and freely filtered by the glomerulus. DTPA is neither secreted nor reabsorbed by the renal tubules, whereas MAG-3 is secreted by the tubules(8). Technetium-99m-L,L-ethylenedicysteine (^{99m}Tc-EC) is a relatively new agent and is now being widely used for DRS(9, 10).

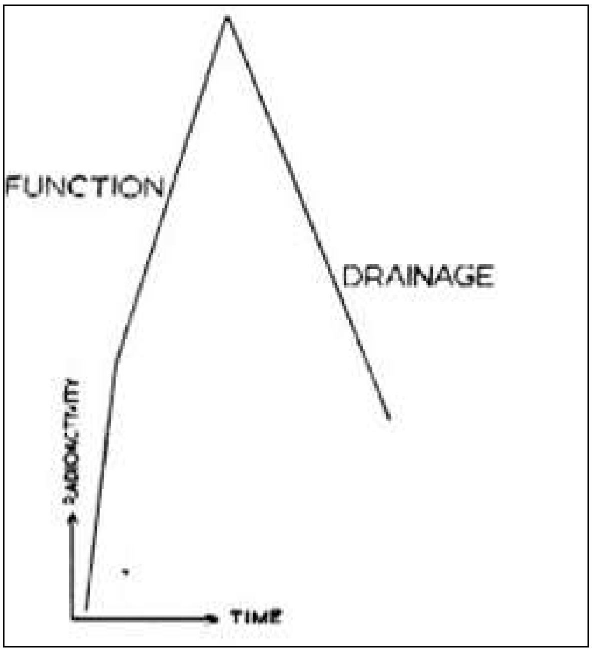


Fig 3: Normal renogram from one renal unit.

Dynamic renal scintigraphy allows estimation of three parameters of renal function: blood flow to the kidney, renal clearance [11] and excretion from the kidney (obstruction). Figure 3 shows a normal renogram from one renal unit. The initial steep upstroke represents radioactivity in the aorta and abdominal vasculature and lasts of 30 to 60 seconds. The second part of the rise reflects renal uptake i.e. function and takes 2 to 4 minutes to reach its peak. The subsequent downslope is the excretory phase [12]. The clearence half time of a normal renal unit after furosemide administration is less than 10 minutes. A delay of 20 minutes or more is associated with significant obstruction. Values between 10 and 20 minutes are considered intermediate.

Clearence half time in isolation however cannot be used to diagnose obstruction. Other factors like differential renal function (DRF) and curve analysis along with ultrasound findings and clinical data determine the presence of obstruction especial postoperatively [13]. Nam *et al.* used a modified DRF measurement calculated according to cross-sectional area which they claim had fewer false negative results [14]. This could be particularly useful in equivocal circumstances.

In the present clinical context DRF largely determines the intervention. A DRF of more than 35% would warrant conservative treatment if the degree of hydronephrosis is within acceptable limits. Any function less than 35% on the initial scan or a decrease in function of 10% on follow up scans would be considered for pyeloplasty.

DRS needs to be interpreted with caution in poor or immature renal units and in massively dilated pelvises. Other factors like the region of interest, time of measurement, state of hydration, bladder fullness, reservoir effect, type of protocol and renal response to furosemide can influence the results of differential function [15].

The concept of supranormal function, i.e. DRF more than 55% in the obstructed kidney, has been much debated. There is no consensus regarding the significance or causes of this phenomenon. Ham *et al.* rule out the theory that supranormal DRF is due to an increased nephron volume [16]. Oh *et al.* [17] and Capolicchio *et al.* [18] believe that supranormal function is an adverse prognostic factor.

Micturating cystouretherogram (MCU)

MCU was routinely used in the investigation of antenatally detected hydronephrosis. An MCU is an invasive unpleasant experience for most children and some authors have challenged its routine usage [19]. It is reserved for children with bilateral hydronephrosis or a dilated ureter on ultrasound and those with a history of febrile UTI and hydronephrosis.

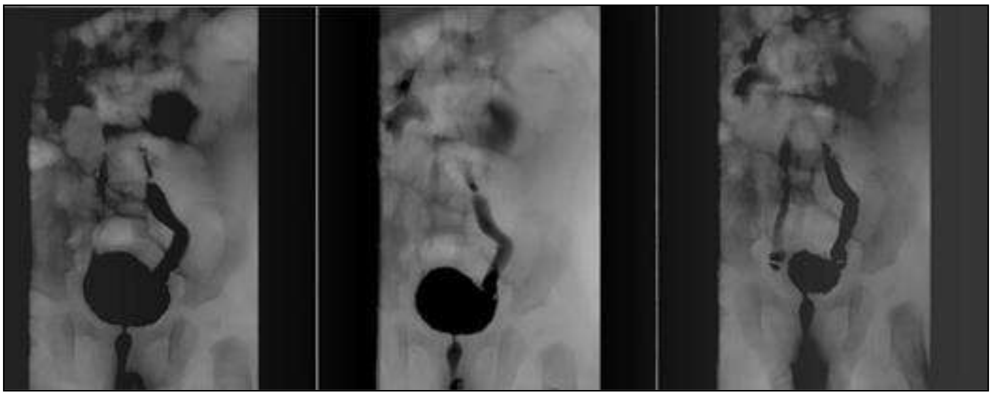


Fig 4: MCU showing bilateral major reflux with PUJO

Magnetic Resonance Urography (MRU)

MRU is the most recent addition to the armamentarium of investigations for renal anomalies. It offers excellent anatomic resolution and soft tissue contrast without using ionizing radiation. The use of Gadolinium has enhanced the MRU further by providing it functional capabilities comparable to DTPA [20}. The drawback lies in the need for sedation or anaesthesia in children and the cost and availability. Also spatial reconstruction and interpretation is a cumbersome process.

Intravenous pyelography (IVP) and Whitaker test

Intravenous pyelography and Whitaker test are mentioned only for completion. IVP is helpful in delineating anatomy clearly but is inaccurate if function is poor, requires use of nephrotoxic contrast and involves radiation exposure.

Whitaker test is the only study that measures directly the pressure in the renal pelvis/bladder. It is however invasive, not reproducible, gives no functional information and involves radiation exposure.

Retrograde pyelogram (RGP)

An RGP is not essential in the diagnostic work up of PUJO. It however precisely identifies the location of obstruction and rotation of kidney and excludes the presence of distal obstruction.

Biochemical markers

The use of transforming growth factor b1(TGF-b1), monocyte chemotactic protein 1 (MCP-1), and endothelin-1 is under review.

Investigation algorithm for antenatal hydronephrosis

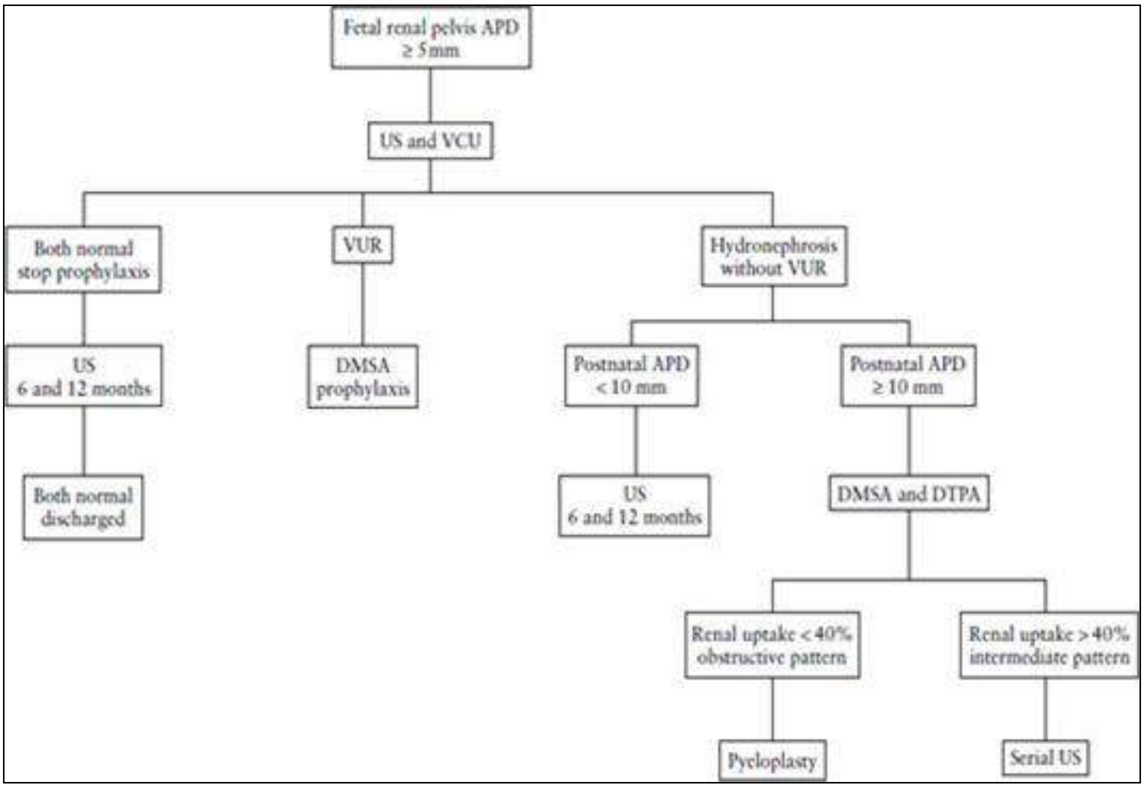


Fig 5: Algorithm proposed by Bouzada *et al.* [4] for the investigation of antenatally detected hydronephrosis.

Management

In the past, children with PUJO presented with symptoms. It was thus logical to operate to relieve those symptoms. The indications for pyeloplasty in asymptomatic children with prenatally detected PUJO remain controversial. The end point of all approaches remains the preservation of renal function. Discussed below are the various approaches, controversies and guidelines.

Observation or early surgery?

There are two opinions regarding the initial management of PUJO – watchful waiting or early surgery. There is now a global consensus toward initial observation instead of surgery in the newborn period and infancy [3]. Strict surveillance is required when a child is being treated conservatively and caregivers must understand the need for close follow up [5].

The proponents of early surgery believe that renal function does not recover after pyeloplasty to the predeterioration status. It is thus not necessary to wait for deterioration. Rather it is better to operate early and preserve maximum function in the obstructed kidney [21].

When to operate?

The indications for pyeloplasty can be briefly summarised as:

- Symptomatic PUJ obstruction, e.g. pain, infection, palpable renal mass.
- Asymptomatic obstruction with reduced function (less than 35–40%) at the time of initial evaluation, particularly if the AP diameter of the renal pelvis exceeds 30 mm
- Failure of conservative management, i.e. deteriorating function of more than 10% or increasing dilatation.
- Persisting asymptomatic obstruction with increasing dilatation with stable differential function [22].

Which operation to perform?

There several surgical options and although the Anderson Hynes pyeloplasty is the most popular operation a knowledge of the other techniques is useful.

Pyeloplasties are broadly divided into dismembered and non dismembered.

Dismembered pyeloplasty

The dismembered pyeloplasty described by Anderson Hynes involves the excision of the adynamic segment of the PUJ and reanastamosis to the pelvis with or without pelvic reduction.

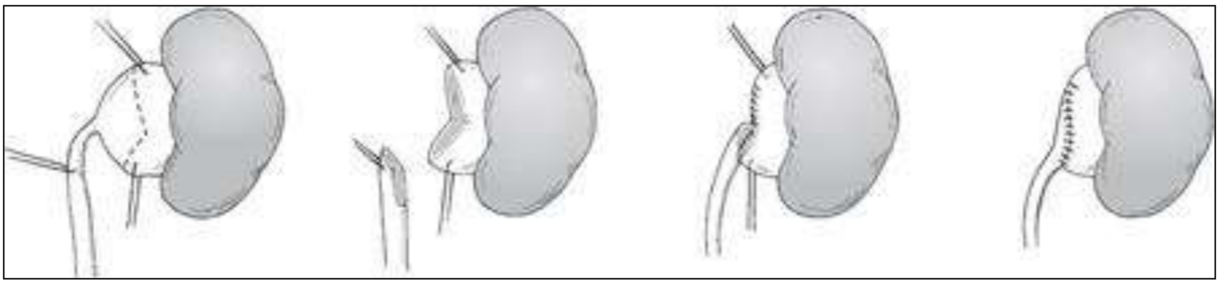


Fig 6a: Anderson Hynes pyeloplasty

Non dismembered pyeloplasty

The non-dismembered pyeloplasties used different flaps of the dilated pelvic tissue to widen the narrow PUJ.

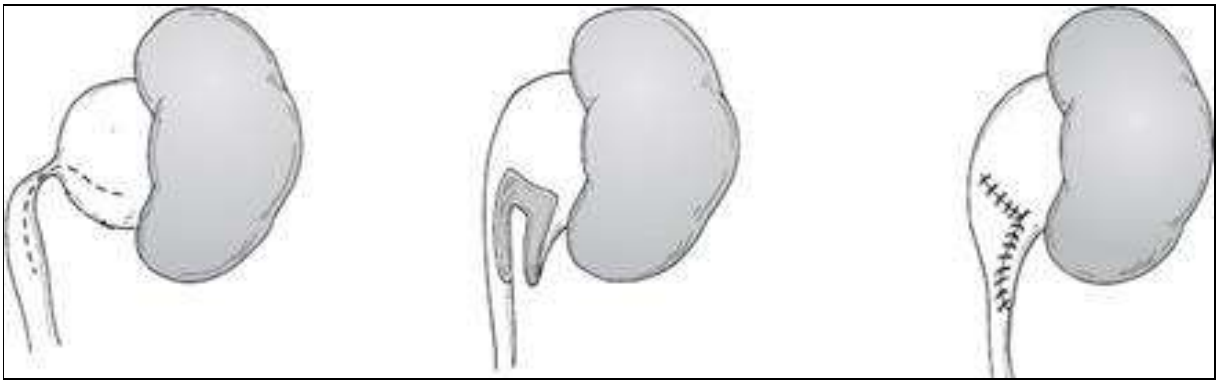


Fig 6b: Foley Y-V plasty

The Foley Y-V plasty makes a Y incision from the ureter to the pelvis and converts it to a V. It is useful in cases of high insertion of the ureter.

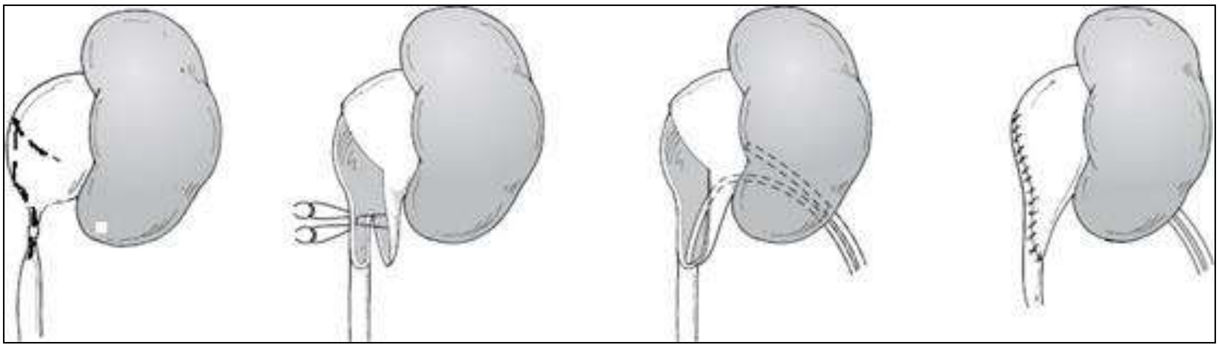


Fig 6c: Culp De Weerd spiral flap pyeloplasty

The Culp–DeWeerd spiral flap pyeloplasty uses a spiral flap which is used to bridge the gap in the ureter and is especially useful in long segment strictures [23].

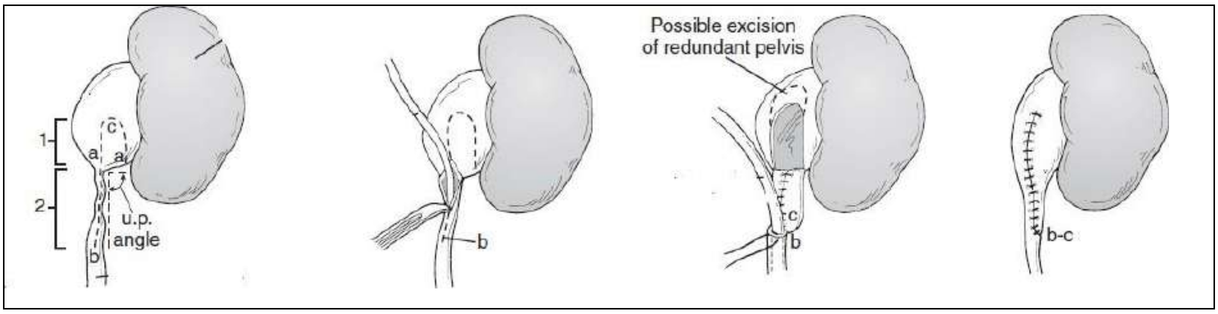


Fig 6d: Scardino and Prince vertical flap

Scardino and Prince use a vertical flap (Fig d). This is useful in a dependent PUJ with a large square extra renal pelvis [24].

Tissue handling and Suture material used?

The judicious use of traction sutures allows for minimal handling of the pelvis and ureter. Handling leads to more postoperative oedema. Stentless operations especially require minimal handling of the tissues.

An avascular plane is usually located outside the intrinsic blood supply of the pelvis. Recurrent preoperative infection or urinary leak causes fibrosis and mobilization of the pelvis is more difficult.

The use of absorbable monofilament sutures is preferred. The use of finer suture materials like 5-0 to 7-0 has made possible a water tight anastamosis. Suturing is started at the apex and attention must be paid to maintaining a patent lumen. Continues or interrupted sutures may be used.

Stented versus non stented pyeloplasty

The proponents of stented pyeloplasty believe that it provides complete urinary diversion and decreases the risk of urinary leak. It also maintains ureteral calibre and anastamotic alignment. Others argue that an external stent increases the length of hospital stay and stents cause more urinary infection. Evidence suggests that stented and non stented repairs are equally successful [25].

There are two types of stents that can be used in pyeloplasty – internal stent eg, Double J stent or an external stent eg, transanastamotic nephrostomy/ pyelostomy stent. External stent usages has its putative complications which include stent blockage, dislodgement, bleeding and persistent urinary leak from the flank [25]. The internal stent on the other hand may get blocked and more importantly when introducted antegradely may coil at the ureterovesival junction causing problems at removal. Chandrasekharam found that placing the stent by retrograde cystoscopy resulted in less malposition [26].

Minimally invasive versuss open pyeloplasty

In the paediatric population open pyeloplasty is the gold standard for PUJO repair with success rates up to 99% [27]. Minimally invasive techniques like retrograde ureteroscopic endopyelotomy with the holmium:YAG laser [28] or ureteral cutting balloon catheter [29] have been tried but the failure and complication rates are unacceptably high.

Laparoscopic pyeloplasty provides the first viable minimally invasive alternative to repair PUJO [30]. However few studies have compared the results of laparoscopic versus open pyeloplasty and the numbers are small. Barga *et al.* compared three groups: laparoscopic pyeloplasty and open pyeloplasty done though a flank and dorsal lumbotomy incision. They found that laparoscopic pyeloplasty took significantly longer. This however may not hold true once more experience is gained in laparoscopy. Laparoscopic pyeloplasty is associated with decreased narcotic use and less pain compared to open procedures, thus contributing to a faster convalescence and earlier hospital discharge. They also found that the hospital stay was shorter for laparoscopic surgery than open. This shorter hospital stay could simply reflect a growing trend toward earlier discharge, which is effectively more pronounced for the more recently introduced method [31]. Piaggio *et al.* found that there is a higher rate of urinary leak in laparoscopic pyeloplasty [32]. This is attributed to the difference in tissue handling and the suture materials used. A meta analysis conducted by Seixas- Mikelus *et al.* revealed that the complication rates of laparoscopic pyeloplasty were double that of open pyeloplasty [33]. Laparoscopy is a good option for older children but in infants open pyeloplasty is still the safe alternative.

The open pyeloplasty has evolved over time from using a large muscle cutting incision to using a muscle splitting incision less than 2.5 cm. This is comparable to the combined laparoscopy incision and narcotic requirement is minimal [31]. Patient age, body habitus and surgeon experience are factors that may have a role in selecting patients who could potentially benefit from one technique over others.

Table 2: Summary of the pros and cons of open and laparoscopic pyeloplasty.

Feature	Laparoscopic pyeloplasty	Open pyeloplasty
Cosmesis	Good	Comparable
Hospital stay	Shorter	Changing trend toward shorter
Narcotic usage	Less	More
Operating time	Longer	Shorter
Learning curve	Longer	Insignificant
Tissue handling	Bad	Good
Complications	More	Less
Optimal for	Older children, redo pyeloplasty	Infants

Postoperative Follow Up

Open dismembered pyeloplasty in children has reported success rates of up to 99% [27]. Therefore the postoperative follow up of children after pyeloplasty, especially when the test involves exposure to ionizing radiation, has raised concerns.

What test to use?

The DRS is at present the most widely used tool to determine the outcome of pyeloplasty. The parameters of interest postoperatively are relief of obstruction and improvement in SRF. DRS is an invasive procedure and requires the use of ionizing radiation. Almodhen *et al.* examined the use of ultrasound in the postoperative follow up and found that patients who show a downgrading of hydronephrosis in the postoperative scan might not require a DRS to rule out obstruction [34]. Cost *et al.* elegantly concluded form their experience that post pyeloplasty imaging should aim to identify those who require further intervention. They demonstrated that at- risk patients could be identified by a screening ultrasound and only selective patients needed to be subjected to a DRS. This will improve compliance and decrease cost and radiation exposure [2]. Chipde *et al.* went further to say that pelvic anteroposterior diameter, pelvic cortical ratio and pelvic urine protein-to-creatinine ratio are the most useful parameters to predict improvement in renal function after pyeloplasty [35].

How long is long enough?

Barga *et al.* in their study compared retrograde endopyelotomy to redo pyeloplasty for failed pyeloplasty. They observed that recurrent obstruction can occur in the immediate postoperative period, soon after indwelling stent removal or several years later, raising questions about the timing, frequency and duration of follow up after pyeloplasty in children [27]. Poosy *et al.* in their long term follow up of pyeloplasty found that renal units that show an unobstructive curve one year post pyeloplasty never had problems on later DRS. These findings were corroborated by Pohl *et al.* who stated that no follow up was required if the renogram done three months post operatively showed a unobstructed flow. However, renal units with half-times greater than 20 minutes and no functional loss may require longer follow up. Any obstructed system showing functional deterioration would require immediate intervention [36].

Venkatesh K. L. (2017) [37] observed that pelviureteric junction obstruction commonly present with antenatal hydronephrosis. The aim was to report and analyze the clinical spectrum of infantile pelviureteric junction obstruction. Retrospective descriptive study of infants operated for pelviureteric junction obstruction (PUJO) during 2013- 2016. Clinical presentations, management and follow up were analyzed. They observed that there were 44 infants involving 48 PUJO renal units of who were nine girls. The sex distribution was 1:3.8. Mean age of the presentation was three months. PUJO was bilateral in four patients. Two patients had unilateral PUJO of lower moiety of duplex system. Median of anteroposterior diameter (APD) and differential function of kidney on EC was 2.5cms and 28% respectively. Three patients had poorly functioning kidneys (PFK) (<10%). They concluded that good antenatal counselling and appropriate postnatal evaluation detects PUJO early. Early infantile pyeloplasty is safe and effective. Routine micturating cystourethrography is debatable in pelviureteric junction obstruction.

Akram M. *et al.* (2018) [38] revealed that the short-term results of stented versus nonstented open Anderson–Hynes dismembered pyeloplasty regarding operative time, hospital stay, functional outcome, and complications. Twenty-seven pediatric open Anderson–Hynes dismembered pyeloplasties were performed for primary pelviureteric junction obstruction (PUJO) by a single team at a single institution from November 2009 to October 2012. Preoperative investigations included renal function tests, urine microscopy, culture, and sensitivity, renal ultrasonography, and diethylenetriamine pentaacetic acid (DTPA). Patients were simply randomized into two groups: group I, the stented group (either nephrostent or JJ stent), and group II, the nonstented group. Outcome was analyzed with respect to operative time, hospital stay, postoperative complications, postoperative effect on hydronephrosis, and postoperative differential renal function (DRF). Minimal follow-up was 6 months. They observed that this study included 27 pediatric patients with primary PUJO, 14 patients in group I and 13 patients in group II. The mean age was 5.7±2.6 years. Twelve (44.4%) cases were right sided and 15 (45.6%) were left sided; no bilateral cases were present. The mean DRF preoperatively was good in both groups (37.5% for group I vs. 35.6% in group II). There was no significant difference in operative time between both groups. The hospital stay was significantly shorter in the stented group, but this was mainly related to postoperative care policy in both groups. There was no significant difference between both groups regarding the complication rate. Postoperative DRF as well as hydronephrosis were significantly improved in both groups, but there was no statistically significant difference between both groups. They concluded that the use of stents in pyeloplasty is not justified as a routine. The overall success and complication rates are independent of whether or not to drain or of the method of drainage. Therefore, it seems that the choice depends on local circumstances and surgeon preference. A larger number of patients is needed to validate these results.

Materials and methods
This study was conducted in patients coming to the surgical ward through surgical outpatient department of S N M C, Agra from December 2016 to June 2018.

Type of study
Prospective randomized controlled study

Selection of cases
A total of 50 patients with Congenital PUJ obstruction coming to department of surgery S N M C Agra was included in the study.

Methods
Patients were divided into two groups-

1. Congenital PUJ Obstruction treated with Stent Pyeloplasty,
2. Congenital PUJ Obstruction treated with Stentless Pyeloplasty.

Inclusion criteria
- Age <16 yrs,
- Patients with DRF >20%,
- Patients with bilateral functional kidneys
- Patients without associated renal calculus

Exclusion criteria
- Age >16 yrs,
- Single kidney patients,
- Secondary or recurrent PUJ obstruction,
- Patient with DRF <20%,
- Patient with associated renal calculus,
- Patients with chronic debilitating disease

Follow-up
Patients will be followed up for the period of 6 months in terms of-

- postoperative complications
- postoperative effect on hydronephrosis
- postoperative differential renal function (DRF)

Observations
This study was conducted in patients coming to the surgical ward through surgical outpatient department of S N M C, Agra from December 2016 to June 2018.

Table 3: Distribution of cases according to age

Age	Stented Group (n=25)		Non-stented group (n=25)	
	No.	%	No.	%
4-12 months	10	40	12	48
1-5 yrs	8	32	6	24
6-10 yrs	5	20	4	16
11-16 yrs	2	8	3	12
Mean±SD	4.13±3.58		4.20±3.99	

The above table shows that among the 50 patients who underwent pyeloplasty, were divided into two groups. Each group contain 25 patients.

Age of patients range from 4 month to 16 years. The mean age of 4.13 in Stented group and 4.20 years in Non-stented group.

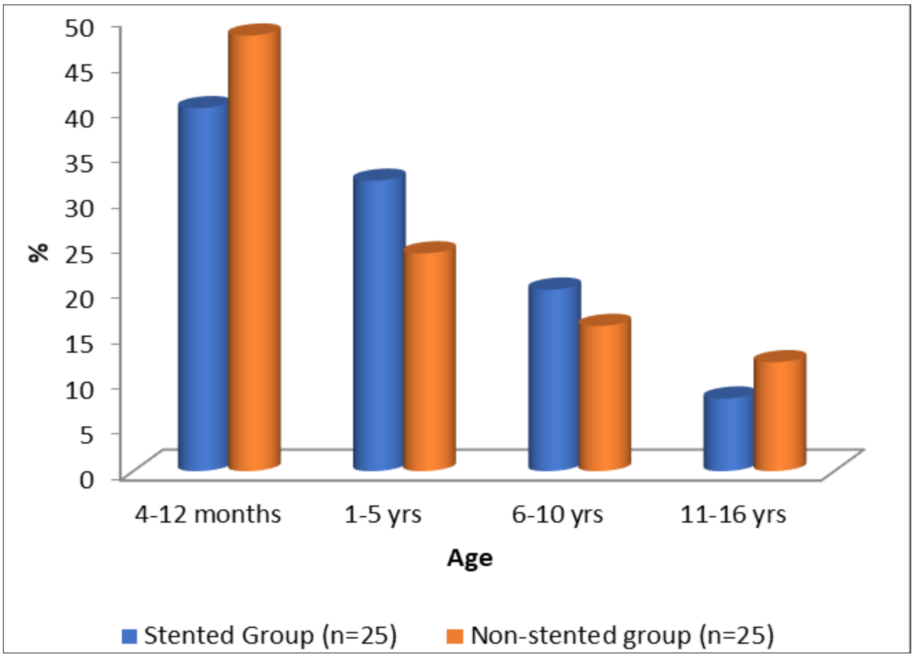


Fig 7: Distribution of cases according to age

Table 4: Distribution of cases according to sex

	Stented Group(n=25)		Non-stented group(n=25)	
	No.	**%**	**No.**	**%**
Male	15	27	12	21
Female	10	18	13	23
Total	25	100	25	100
Mean±Sd	18.33±1.57		19±1.72	

There were more male children 15 (27%) then female children 10 (18%) in stented group and more female children 13 (23%) then male children 12 (21%).
Total male children 27 (54%) out of 50 patients.
Total female children 23 (46%) out of 50. Male to female ratio 1:17.

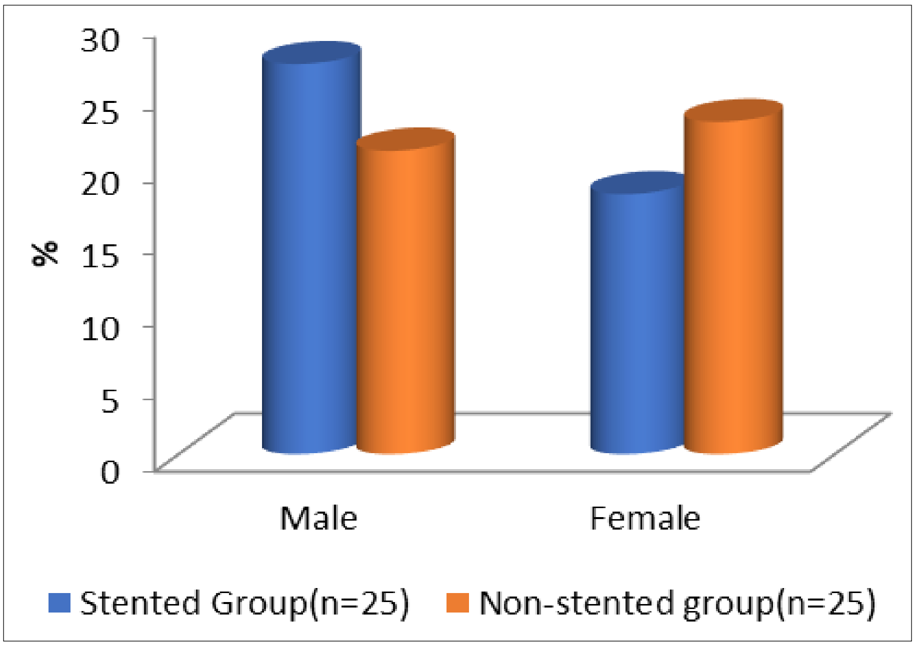


Fig 8: Distribution of cases according to sex

Table 5: Distribution of cases according to etiology

	Stented Group(n=25)		Non-stented group(n=25)	
	No.	%	No.	%
Intrinsic factor	15	60	17	68
Extrinsic factor	8	32	6	24
Polyp	2	8	2	8
mean±sd	10±1.46		10.67±1.53	

Out of two groups, in stented group patients 15(60%) children having intrinsic factor, 8 (32%) having extrinsic factor and 2 (8%) having polyp responsible for pelviureteric junction obstruction.

In second group non stented group 17 (68%) children having intrinsic factor, 6 (24%) having extrinsic factor and 2 (8%) having polyp responsible for pelviureteric junction obstruction.

There was no significant different between in distribution of pateints in two study groups with respect to etiology.

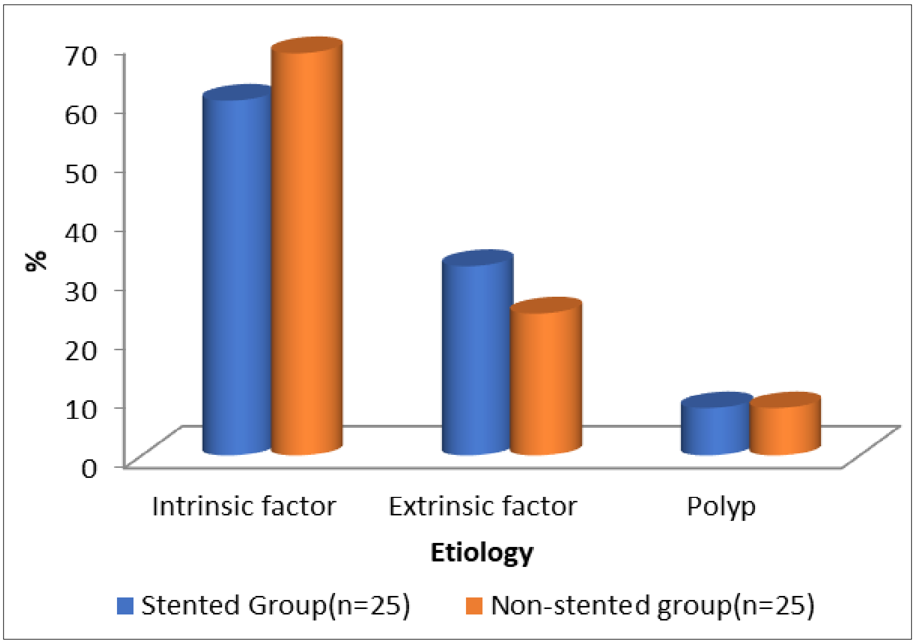


Fig 9: Distribution of cases according to etiology

Table 6: Symptoms in both group

Symptoms	Stented Group(n=25)		Non-stented group(n=25)	
	No.	%	No.	%
UTI	4	16	6	24
Pain	10	40	10	40
Hematurit	6	24	5	20
Prenatal sonography	5	20	4	16
mean±sd	6.25±0.91		6.25±0.91	

Out of two groups, in stented group 4 (16%) children presented with UTI, 10 (40%) children presented with pain in abdomen, 7 (24%) children presented with blood in urine, out of 25 children of group 1, 5 children were diagnosed as prenatal sonography.

In non-stented group 6 (24%) children presented with UTI, 10 (40%) children presented with pain in abdomen, 5 (20%) children presented with blood in urine, out of 25 children of group 2,4 children were diagnosed as prenatal sonography.

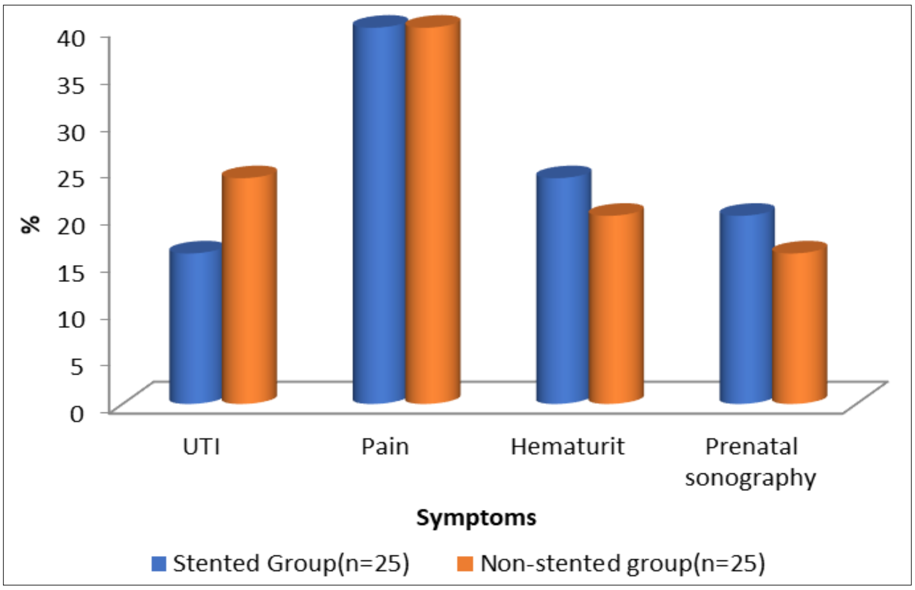


Fig 10: Symptoms In Both Group

Table 7: Post-operative changes of ultrasonography detected hydronephrosis in stented group

	Pre-op usg detected hydronephrosis (n=25)		Postoperative usg detected hydronephrosis(n=25)							
			Normal		Severe		Moderate		Mild	
Degree of HN	No	%	No.	%	No.	%	No.	%	No.	%
Severe HN	12	48	8	32	1	4	1	4	2	8
Moderate HN	8	32	5	20	-	-	2	8	1	4
Mild HG	5	20	3	12	-	-	1	4	1	4
total	25	100	16	64	1	4	4	16	4	16
Mean±Sd	8.33±0.99		4.67±0.58		0.33±0.82		1.33±0.41		2±0.58	

In stented group out of 25 patients, 12 patients on preoperative USG were diagnosed a s a care of severe hydronephrosis after post operatively, 8 patients were normal, 1 patients having moderate hydronephrosis, 2 patients having mild hydronephrosis and only 1 patient having severe hydronephrosis or postoperative ultrasonography findings.

Out of 25 patients 8 patients were diagnosed as moderate hydronephrosis on preoperative ultrasonography after stented pyeloplasy 5 patient were normal, 2 patients having moderate hydronephrosis, only 1 patient having mild hydronephrosis on postoperative ultrasonographic.

Out of 25 patients, 5 patients were diagnosed as case of mild hydronephrosis on preoperative ultrasonography, after stented pyeloplasty 3 patients were normal 1 patient having mild hydronephrosis and 1 patient having moderate hydronephrosis on postoperative ultrasonography.

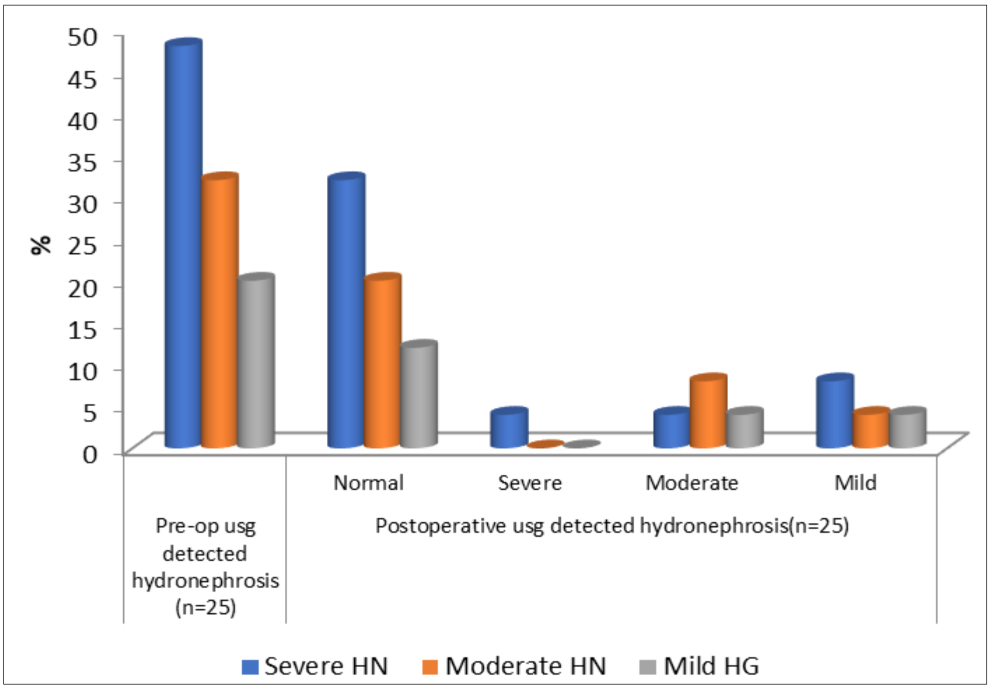


Fig 11: Post-operative changes of ultrasonography detected hydronephrosis in stented group

Table 8: Post-operative changes of ultrasonography detected hydronephrosis in non-stented group

	Pre-op usg detected hydronephrosis (n=25)		Postoperative usg detected hydronephrosis(n=25)							
			Normal		Severe		Moderate		Mild	
Degree of HN	No	%	No.	%	No.	%	No.	%	No.	%
Severe HN	10	40	5	20	1	4	1	4	3	12.0
Moderate HN	9	36	4	16	-	-	2	8	3	12.0
Mild HG	6	24	4	16	-	-	-	-	2	8.0
Total	25	100	13	52	1	4	3	12	8	32.0
mean±sd	8.33±0.59		4.33±0.23		0.33±0.82		1±0.82		2.67±0.29	

In non-stented group out of 25 patients, 10 patients were diagnosed a s a case of severe hydronephrosis on preoperative ultrasonography after non stented pyeloplasty, out of 10 patients, 5 patients were normal, only 1 patient having severe hydronephrosis, 1 patient having moderate hydronephrosis and 3 patients having mild hydronephrosis on postoperative ultrasonography findings. Out of 25 patients 9 patients were diagnosed as case of moderate hydronephrosis on preoperative ultrasonography findings, after nonstented pyeloplasty out of 9 patients 4 patient were normal, 3 patients having mild hydronephrosis, and 2 patients having moderate hydronephrosis on postoperative ultrasonographic.

Out of 25 patients, 6 patients were diagnosed as case of mild hydronephrosis on preoperative ultrasonography, out of 6 patients after non-stented pyeloplasty 4 patients were normal and rest 2 patients having mild hydronephrosis on postoperative ultrasonography.

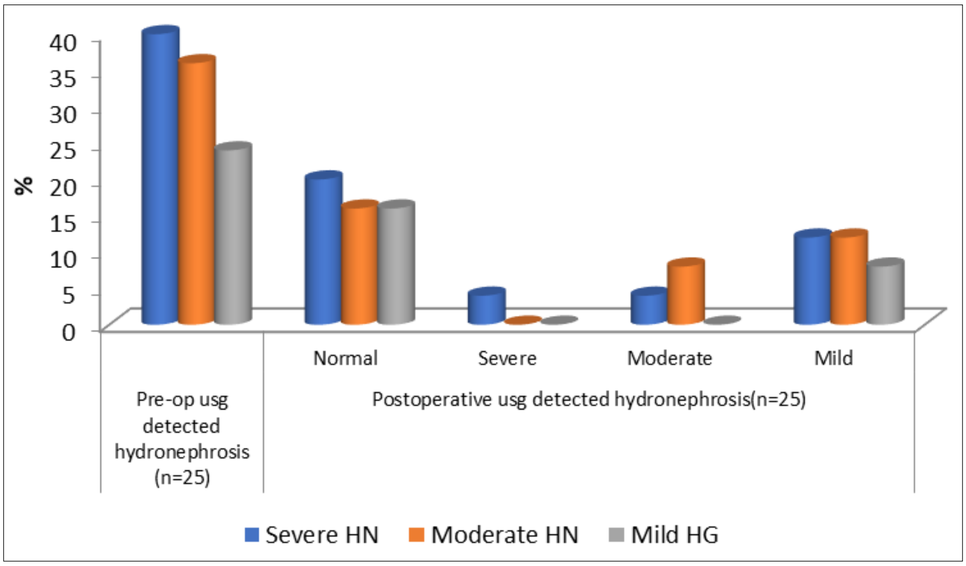


Fig 12: Post-operative changes of ultrasonography detected hydronephrosis in non-stented group

Table 9: Complications

Complications	Stented Group (n=25)		Non-stented group (n=25)	
	No.	%	No.	%
Prolonged Drainage	3	27	2	12
Urinoma	2	18	1	6
Fever	2	18	1	6
Frequency and dysuria	1	9	5	29
Flank pain	1	9	3	18
Hematuria	1	9	2	12
UTI	1	9	3	18
mean±sd	1.57±0.58		2.43±0.83	

In above table in first group out of 25 patients only 11 patients having post operative complications in the form of prolonged drainage, urinoma and fever.

In second group of 25 patients only 17 having postoperative complications in the form of frequency, dysuria, hematuria, UTI and pan.

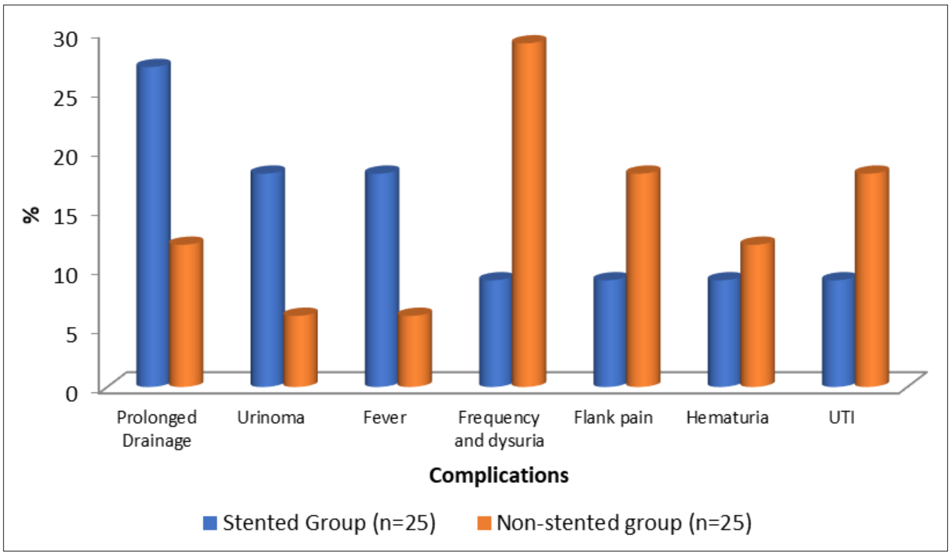


Fig 13: Complications

Table 10: Comparison of recurrence of complications according to the ureteral stent in pyeloplasty

Recurrence	Stented Group (n=25)		Non-stented group (n=25)	
	No.	%	No.	%
Present	4	16	6	24
Absent	21	84	19	76
Total	25	100	25	100
mean±sd	12.5±2.40		12.5±1.84	

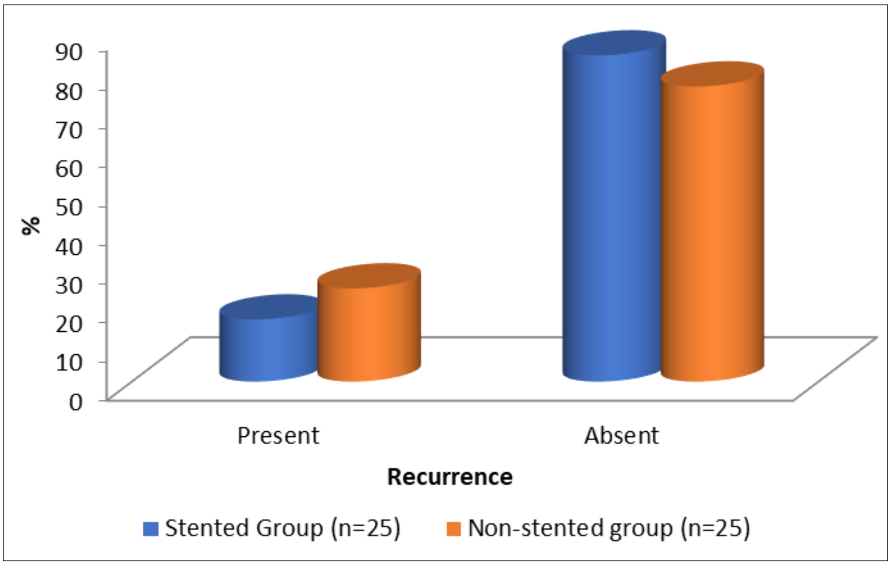


Fig 14: Comparison of recurrence of complications according to the ureteral stent in pyeloplasty

Table 11: Comparison of Hun between the stented and non-stented group

SFU grading of ydronephrosis	Stented Group (n=25)	Non-stented group (n=25)	p value
Pre-operative	3	2.92	0.521
Post-operative (after 1 year)	1.94	1.91	0.149

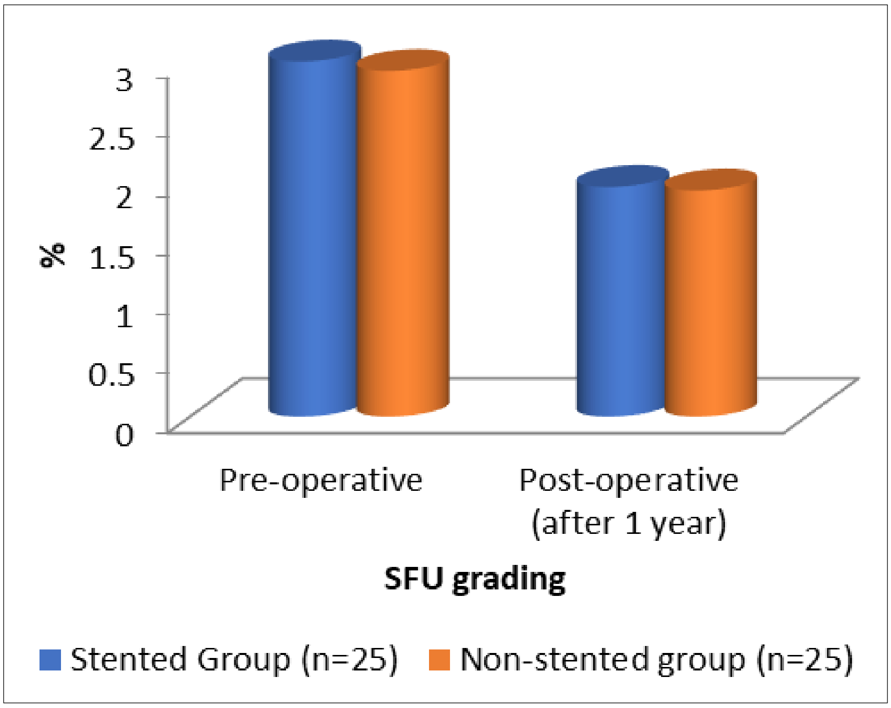


Fig 15: Comparison of Hun between the stented and non-stented group

Table-12: Comparison of hun between the stented and non-stented group

Anteroposterior pelvic diameter	Stented Group (n=25)	Non-stented group (n=25)	p value
Pre-operative	35.4	30.1	0.501
Post-operative (after 6 months)	14.5	14	0.372

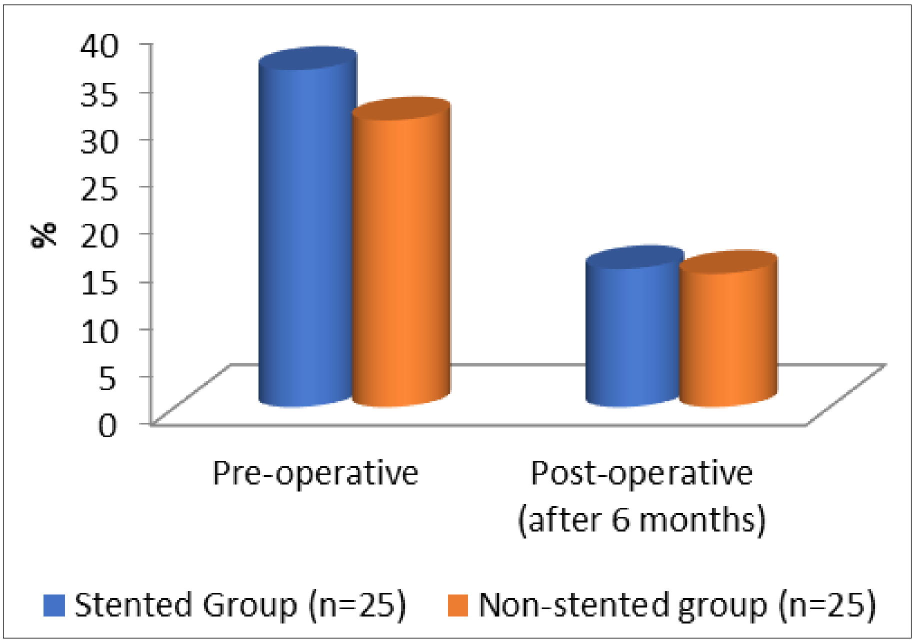


Fig 16: Comparison of hun between the stented and non-stented group

Table 13: Hospital stay (days)

	Stented group	Non-stented group
Hospital stays	2.6	7

Table 14: Neonatal hydronephrosis is defined as SFU grade ≥ 1 or renal APD ≥ 7 mm

	SFU	Pattern of renal sinus splitting
	Grade-0	No splitting
Mild	Grade-1	Slight splitting
	Grade-2	Urine fills renal pelvis with or without major calyceal dilatation
Moderate	Grade-3	Grade-II+ uniform dilatation of minor calyces with preserved renal parenchyma
Severe	Grade-4	Grade-III+ parenchymal thinning

Discussion

Although dismembered pyeloplasty has become a well-accepted gold standard treatment modality for UPJ obstruction, the question of whether postoperative urinary diversion after pyeloplasty is beneficial has been debated for decades, particularly in infants and smaller children who have narrow ureters. There are many ways to divert urine, and different types of drainage methods have been described in the literature, including nephrostomy tube drainage, internal ureteral stents such as the double 'J' stent, external stent anastomosis, and a combination of these modalities [43-44]. In the original report of Anderson and Hynes, they clearly supported non-stented repair for UPJ obstruction and claimed that a nephrostomy tube or internal stent caused urinary tract infection, fibrosis at the suture line, and recurrent UPJ obstruction and hindered healing of the anastomosis site [45]. However, as operative techniques have evolved and postoperative complications such as urine leakage have been reported, the standard operative technique has evolved to include a urinary diversion modality such as a nephrostomy tube or internal ureteric stent to prevent urine leakage at the anastomosis site. Several favorable reports on the use of internal stents have been published in recent years showing their several advantages [46, 47].

The advantages of a double 'J' stent compared with a nephrostomy tube include a shorter hospital stay and a lower morbidity rate [48, 49]. Furthermore, double 'J' stents prevent adhesion to the suture site by splitting the suture line, help to maintain an appropriate diameter and alignment of the ureter, and limit ureter kinking [50].

Woo and Farnsworth [51] used only internal ureteral stents rather than both a stent and a nephrostomy tube because the former showed a low rate of postoperative complications and a decreased postoperative hospital stay. Ninan *et al.* [46] reported a review of the records of 60 patients who underwent pyeloplasty in 2008. They strongly recommended double 'J' stenting, claiming that it was the safest mode of drainage in pediatric pyeloplasty. None of their 58 stented patients developed stricture of the anastomosis site, whereas 1 of the 3 patients who did not receive a stent developed stricture of the anastomosis site requiring redo pyeloplasty. The other two patients who had a ureteric stricture responded to balloon dilatation. In addition, they also reported a mean hospital stay of 2.6 days in the stented patients and that the majority of the patients could be safely discharged on the second postoperative day. On the other hand, the mean hospital stay of the nonstented patients was 7 days. The disadvantages of the double 'J' stent include that it can cause stent-related complications such as urinary tract infection and provoke obstruction of the ureter by irritating the mucosa of the ureter or the renal pelvis.

Furthermore, leaving a double 'J' stent in neonates or pediatric patients requires additional general anesthesia for removal. In recent years, there has been a favorable tendency toward nonstented pyeloplasty [52, 53]. Braga *et al.* [53] evaluated influential factors associated with recurrent UPJ obstruction and concluded that stenting did not affect the long-term outcomes after pyeloplasty. This result was also found in the present study.

We found no significant difference between the nonstented group and the stented group in terms of improvement of hydronephrosis (Table 2). The overall numbers of recurrent UPJ obstruction in each group (2 of 22 vs. 2 of 54) were the same in the current study, and the recurrence rate of UPJ obstruction in the stented group (9%) was slightly higher than in the nonstented group (4%). Despite this, there was no significant difference in the recurrence rate between the groups (p=0.575) (Table 3).

Fortunately, no other complications associated with the operation, which may require additional procedures and a longer hospital stay, occurred in either group. Smith *et al.*[54] compared the differences in complications or intervention rates in the stented (n=52) and nonstented (n=65) groups and reported that urinary tract infection occurred in 3 of 52 stented cases (6%) versus 1 of 65 nonstented cases (2%). Prolonged drainage or urinoma occurred only in nonstented cases (3% or 5% each). However, the overall rate of urological complications in each group was similar: 12% in the stented and 15% in the nonstented group. Therefore, the choice of postoperative urine drainage should be made by surgeon's preference rather than by the perceived complication rate or the duration of hospital stay.

Currently, the selection of the pyeloplasty approach in children with UPJ obstruction mostly depends on the surgeon's preference and experience. Although several studies have been conducted in patients with UPJ obstruction, their sample sizes were small and the true effectiveness and advantages of LP over open pyeloplasty in children have not yet been clearly demonstrated [24, 25].

Although it was suggested that early repair of UPJ obstruction could prevent irreversible renal damage and improve renal function [57], other studies failed to demonstrate that pyelocaliectasis was easier to resolve postoperatively in the infant kidney [58]. It is more likely that patient ages at repair may have a minor role in the eventual resolution of hydronephrosis. However, the effect of patient ages at repair should be evaluated in further prospective studies with larger samples and long-term follow-up.

Numerous studies have investigated whether stents are needed during pediatric pyeloplasty, but the question remains unanswered and the decision remains controversial and largely surgeon dependent. Even among proponents of urinary diversion, the optimal method remains unclear [59, 60]. However, the original report by Anderson and Hynes [61] described a stentless procedure; currently, one can find reports supporting no stents [62-65], externalized stents (percutaneous catheter) [66-68], and internalized (JJ) stents [69-71]. Th is plethora of studies proves all methods to be safe and effective, but conflicting summaries of the results have not proved any single method as superior [72].

The supposed advantages of stenting are maintaining alignment of the anastomosis, decreasing urinary extravasation, bypassing the transient obstruction

due to edema at the anastomosis site, preventing subsequent stenosis, and enabling documenting the flow of contrast through a nephrostomy tube [59-62]. However, stents may cause infection, stricture due to pressure of a stent over the anastomosis, injury to the anastomosis or renal tissue, bleeding, dislodgement, fragmentation or migration, calculus formation, and may prolong the hospital stay. In addition, internal stents need a second hospital admission and a general anesthetic for removal [63-67, 69-71]. Nonstenting allo ws early mobilization and freedom from draining tubes [65].

The preoperative data regarding age, sex, side distribution, presentation, degree of hydronephrosis, and DRF were all similar in both groups, with no significant difference. Th is was related to the simple randomization in the assignment of patients to any of the groups. Th e prenatal diagnosis of patients in our series represented a small percentage of patients compared with other studies.

Although the operative time was longer by a few minutes in the stented than in the nonstented group, the difference was not significant. Th is finding is an expected finding, as the insertion of a stent whether internal or externalized is a simple maneuver that takes few minutes to complete. A similar finding was reported by Elmalik *et al.* [69]

The duration of hospitalization has become an increasingly important issue in hospitals that have limited resources and lot of patient load [62, 64, 72]. In our study, the duration of hospitalization was significantly shorter in the stented group. However, this difference was mainly related to a difference in our strategy of postoperative care. As the standard technique in our unit before conducting this study was the stented technique, we were eager to keep an eye on nonstented patients to detect any complications and manage as early as possible. Consequently, we did discharge the stented patients after 1–2 days and recalled them for removal of the stents/drains either in the outpatient clinic or as a day-case procedure, whereas we kept the nonstented patients in hospital until the perirenal drain was dry and was removed. This approach explains the difference in hospital stay, as nonstented patients could have been treated in the same way and been discharged after the acute care has passed, and catheter could have been managed at home. Some authors reported similar results with a shorter hospital stay in the stented group [69-72]. Elmalik *et al.* [69] also explained this diff erence on the basis of keeping patients with PUL inpatient. In contrast, some authors stated that the nonstented group had a shorter hospital stay than the stented group [62-64, 65, 73]. Most of these series explained the longer hospital stay of the stented group on the basis of an increase in the incidence of UTI during the early postoperative period. Hence, the stented group needs parenteral antibiotics for longer periods. However,

The incidence of postoperative complications in both groups was comparable, with no significant difference. It was suggested that earlier removal of stents may reduce the risk for infection[69]. Th e rate of infections increased with stent use and in patients who have PUL (Persistent urinary leakage). Regarding urinary leakage, all patients of the nonstented group had temporary leakage, which ceased before the seventh day, but one patient had prolonged leakage that persisted for 11 days but ceased spontaneously and performed well in the follow-up studies, with no need for stenting. In the literature, PUL is more common in the nonstented repairs [60, 62, 64, 69, 72]. In Arda *et al.* [79] study, there was no statistically significant difference regarding urine leakage through the Penrose drain in the stented and nonstented groups. The rate of PUL was 14% in Liss *et al.* [77] study; all but two were managed expectantly. We had one (7.1%) stent slippage, which passed without complications or further morbidity. Castagnetti *et al.* [80] had 5% rate of stent dislodgement, which were all treated by stent removal with exceptional need for additional procedures.

Smith *et al.* [72] found also that there is no significant difference between the complications of the stented and nonstented repairs; of the 52 stented repairs, complications developed in seven (13%), of which six (12%) were potentially related to stenting. Of the 65 nonstented repairs, complications developed in 11 (17%), of which 10 (15%) were related potentially to lack of stenting [72]. Bayne *et al.* [74] also found no significant difference in the complication rate between the stented and nonstented patients. Elmalik *et al.* [69] analyzed the nature of complications and concluded that complications related to surgical repair were significantly higher in the unsplinted group, whereas stented patients suffered only stent-related complications, namely UTI and stent migration. Th e success rate of open A–H dismembered pyeloplasty varies from 94 to 100% in different series [60, 62, 65, 69, 72, 77].

The outcome of repair regarding improvement of hydronephrosis and DRF was comparable in both groups. Th ere was significant improvement in both parameters as detected by postoperative US and DTPA, with no significant difference between both groups. Th is is consistent with many other reports comparing the two techniques of pyeloplasty [62, 69].

Some surgeons followed the patients only with US and performed an isotope scan only if US showed worsening hydronephrosis or if patients develop symptoms of obstruction [63, 72, 83]. Th e improvement in hydronephrosis observed in US was noted from 3 months postoperatively. Earlier improvement of hydronephrosis in stented than in nonstented patients was described [69, 84]. Some authors denied early improvement in hydronephrosis after pyeloplasty and described improvement from 6 months to 1 year [81, 85, 86].

Despite the comparable results of both techniques in our study and in many other studies, the rate and nature of surgery-related complications in the nonstented group as well as the rate of redo procedures, make a splinted technique preferable in the high-risk group-for example, single kidney patients, revision pyeloplasty, poor overall renal function, and renal stones [62, 72, 82].

Conclusions

In the comparison of the non-stented group and the stented group during dismembered pyeloplasty in children with UPJ obstruction, we found no significant differences in the resolution of hydronephrosis or overall postoperative complications. Therefore, the insertion of an internal ureteral stent during pyeloplasty is not necessary and the choice of an internal ureteral stent for postoperative drainage should be made by surgeon's experience and preference.

The use of stents in pyeloplasty in children is not justified as a routine. Th e success rate does not depend on whether or not to stent or on the type of stent used. Although the rate of complications is comparable in both groups, the nature of complications is different. Whether or not to stent a pyeloplasty in children relies mainly on surgeon preference and local and institutional circumstances. Stenting may be preferable in high-risk patients. However, the number of patients in the study is small and a larger number is needed to strengthen these conclusions.

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References

1. Smith KE, Holmes N, Lieb JI, Mandell J, Baskin LS, Kogan BA, *et al.* Stented versus nonstented pediatric pyeloplasty: a modern series and review of the literature. J Urol. 2002 Sep;168(3):1127-30.
2. Cost NG, Prieto JC, Wilcox DT. Screening ultrasound in follow-up after pediatric pyeloplasty. Urology. 2010 Jul;76(1):175-9.
3. Nelson CP, Park JM, Dunn RL, Wei JT. Contemporary trends in surgical correction of pediatric ureteropelvic junction obstruction: data from the nationwide inpatient sample. J Urol. 2005 Jan;173(1):232-6.
4. Bouzada MC, Oliveira EA, Pereira AK, Leite HV, Rodrigues AM, Fagundes LA, *et al.* Diagnostic accuracy of fetal renal pelvis anteroposterior diameter as a predictor of uropathy: a prospective study. Ultrasound Obstet Gynecol. 2004 Dec;24(7):745-9.
5. Lee RS, Cendron M, Kinnamon DD, Nguyen HT. Antenatal hydronephrosis as a predictor of postnatal outcome: a meta-analysis. Pediatrics. 2006 Aug;118(2):586-93.
6. Yang Y, Hou Y, Niu ZB, Wang CL. Long-term follow-up and management of prenatally detected, isolated hydronephrosis. J Pediatr Surg. 2010 Aug;45(8):1701-6.
7. Ismaili K, Hall M, Donner C, Thomas D, Vermeylen D, Avni FE. Results of systematic screening for minor degrees of fetal renal pelvis dilatation in an unselected population. Am J Obstet Gynecol. 2003 Jan;188(1):242-6.
8. Kass EJ, Fink-Bennett D. Contemporary techniques for the radioisotopic evaluation of the dilated urinary tract. Urol Clin North Am. 1990 May;17(2):273-89.
9. Buyukdereli G, Guney IB. Role of technetium-99m N,N-ethylenedicysteine renal scintigraphy in the evaluation of differential renal function and cortical defects. Clin Nucl Med. 2006 Mar;31(3):134-8.
10. Lima MC, de Lima ML, Pepe CF, Etchebehere EC, Santos AO, Amorim BJ, *et al.* Technetium- 99m-L,L-ethylenedicysteine is more effective than technetium-99m diethylenetriamine penta-acetic acid for excluding obstruction in patients with pyelocalicinal dilation. Urology. 2010 Aug;76(2):283-8.
11. Prigent A, Cosgriff P, Gates GF, Granerus G, Fine EJ, Itoh K, *et al.* Consensus report on quality control of quantitative measurements of renal function obtained from the renogram: International Consensus Committee from the Scientific Committee of Radionuclides in Nephrourology. Semin Nucl Med. 1999 Apr;29(2):146-59.
12. Davies RJ, Jones DJ, Croft DN, Shuttleworth KE. An assessment of Anderson-Hynes pyeloplasty by radioisotope renography. Proc R Soc Med. 1969 Nov;62(11 Part 1):1123-4.
13. Wang TM, Chang PL, Kao PF, Hsieh ML, Huang ST, Tsui KH. The role of diuretic renography in the evaluation of obstructed hydronephrosis after pediatric pyeloplasty. Chang Gung Med J. 2004 May;27(5):344-50.
14. Nam JK, Lee SD, Chung MK. Modified differential renal function measurement revised by renal cross sectional area in children with ureteropelvic junction obstruction. Korean J Urol. 2010 Apr;51(4):271-5.
15. Conway JJ. "Well-tempered" diuresis renography: its historical development, physiological and technical pitfalls, and standardized technique protocol. Semin Nucl Med. 1992 Apr;22(2):74-84.
16. Ham WS, Jeong HJ, Han SW, Kim JH, Kim DK. Increased nephron volume is not a cause of supranormal renographic differential renal function in patients with ureteropelvic junction obstruction. J Urol. 2004 Sep;172(3):1108-10.
17. Oh SJ, Moon DH, Kang W, Park YS, Park T, Kim KS. Supranormal differential renal function is real but may be pathological: assessment by 99m technetium

mercaptoacetyltriglycine renal scan of congenital unilateral hydronephrosis. J Urol. 2001 Jun;165(6 Pt 2):2300-4.
18. Capolicchio G, Jednak R, Dinh L, Salle JL, Brzezinski A, Houle AM. Supranormal renographic differential renal function in congenital hydronephrosis: fact, not artifact. J Urol. 1999 Apr;161(4):1290-4.
19. Kim YS, Do SH, Hong CH, Kim MJ, Choi SK, Han SW. Does every patient with ureteropelvic junction obstruction need voiding cystourethrography? J Urol. 2001 Jun;165(6 Pt 2):2305-7.
20. Darge K, Anupindi SA, Jaramillo D. MR imaging of the abdomen and pelvis in infants, children, and adolescents. Radiology. 2011 Oct;261(1):12-29.
21. McAleer IM, Kaplan GW. Renal function before and after pyeloplasty: does it improve? J Urol. 1999 Sep;162(3 Pt 2):1041-4.
22. Thomas DF. Prenatally diagnosed urinary tract abnormalities: long-term outcome. Semin Fetal Neonatal Med. 2008 Jun;13(3):189-95.
23. Culp OS, De WJ. A pelvic flap operation for certain types of ureteropelvic obstruction; preliminary report. Proc Staff Meet Mayo Clin. 1951 Dec 5;26(25):483-8.
24. Scardino PL, Prince CL. Vertical flap ureteropelvioplasty. South Med J. 1953 Apr;46(4):325- 31.
25. Castagnetti M, Berrettini A, Cimador M, Sergio M, Rigamonti W, DeGrazia E. Complications of trans-anastomotic externalised stents in open pyeloplasty: influence of the method of placement, the duration of stenting, and the associated bladder drainage. Pediatr Surg Int. 2010 Mar;26(3):309- 13.
26. Chandrasekharam VV. Is retrograde stenting more reliable than antegrade stenting for pyeloplasty in infants and children? Urology. 2005 Dec;66(6):1301-4; discussion 4.
27. Braga LH, Lorenzo AJ, Bagli DJ, Keays M, Farhat WA, Khoury AE, *et al.* Risk factors for recurrent ureteropelvic junction obstruction after open pyeloplasty in a large pediatric cohort. J Urol. 2008 Oct;180(4 Suppl):1684-7; discussion 7-8.
28. Giddens JL, Grasso M. Retrograde ureteroscopic endopyelotomy using the holmium:YAG laser. J Urol. 2000 Nov;164(5):1509-12.
29. Faerber GJ, Richardson TD, Farah N, Ohl DA. Retrograde treatment of ureteropelvic junction obstruction using the ureteral cutting balloon catheter. J Urol. 1997 Feb;157(2):454-8.
30. Bansal P, Gupta A, Mongha R, Narayan S, Das RK, Bera M, *et al.* Laparoscopic versus open pyeloplasty: comparison of two surgical approaches- a single centre experience of three years. Indian J Surg. 2011 Aug;73(4):264-7.
31. Braga LH, Lorenzo AJ, Bagli DJ, Mahdi M, Salle JL, Khoury AE, *et al.* Comparison of flank, dorsal lumbotomy and laparoscopic approaches for dismembered pyeloplasty in children older than 3 years with ureteropelvic junction obstruction. J Urol. 2010 Jan;183(1):306-11.
32. Piaggio LA, Franc-Guimond J, Noh PH, Wehry M, Figueroa TE, Barthold J, *et al.* Transperitoneal laparoscopic pyeloplasty for primary repair of ureteropelvic junction obstruction in infants and children: comparison with open surgery. J Urol. 2007 Oct;178(4 Pt 2):1579-83.
33. Seixas-Mikelus SA, Jenkins LC, Williot P, Greenfield SP. Pediatric pyeloplasty: comparison of literature meta-analysis of laparoscopic and open techniques with open surgery at a single institution. J Urol. 2009 Nov;182(5):2428-32.
34. Almodhen F, Jednak R, Capolicchio JP, Eassa W, Brzezinski A, El-Sherbiny M. Is routine renography required after pyeloplasty? J Urol. 2010 Sep;184(3):1128-33.
35. Chipde SS, Lal H, Gambhir S, Kumar J, Srivastava A, Kapoor R, *et al.* Factors predicting improvement of renal function after pyeloplasty in pediatric patients: a prospective study. J Urol. 2012 Jul;188(1):262-5.
36. Pohl HG, Rushton HG, Park JS, Belman AB, Majd M. Early diuresis renogram findings predict success following pyeloplasty. J Urol. 2001 Jun;165(6 Pt 2):2311-5.
37. Lim DJ, Walker RD, 3rd. Management of the failed pyeloplasty. J Urol. 1996 Aug;156(2 Pt 2):738-40.
38. Karnak I, Woo LL, Shah SN, Sirajuddin A, Kay R, Ross JH. Prenatally detected ureteropelvic junction obstruction: clinical features and associated urologic abnormalities. Pediatr Surg Int. 2008 Apr;24(4):395-402.
39. Bomalaski MD, Hirschl RB, Bloom DA. Vesicoureteral reflux and ureteropelvic junction obstruction: association, treatment options and outcome. J Urol. 1997 Mar;157(3):969-74.
40. Hollowell JG, Altman HG, Snyder HM, 3rd, Duckett JW. Coexisting ureteropelvic junction obstruction and vesicoureteral reflux: diagnostic and therapeutic implications. J Urol. 1989 Aug;142(2 Pt 2):490-3; discussion 501.
41. Alizadeh F, Izadpanahi MH, Khorrami MH, Nouri-Mahdavi K. Ureteropelvic junction obstruction presenting after antireflux surgery. Adv Biomed Res. 2012;1:20.
42. Moodley P, Demaria J, Lorenzo AJ, Pippi Salle JL, Braga LH. Concurrent ureteropelvic and ureterovesical junction obstruction in children: the value of retrograde pyelography. J Pediatr Urol. 2010 Apr;6(2):117-21.
43. Austin PF, Cain MP, Rink RC. Nephrostomy tube drainage with pyeloplasty: is it necessarily a bad choice? J Urol 2000;163: 1528-30.
44. Hussain S, Frank JD. Complications and length of hospital stay following stented and unstented paediatric pyeloplasties. Br J Urol 1994;73:87-9.
45. Anderson JC, Hynes W. Retrocaval ureter; a case diagnosed pre-operatively and treated successfully by a plastic operation. Br J Urol 1949;21:209-14.
46. Ninan GK, Sinha C, Patel R, Marri R. Dismembered pyeloplasty using double 'J' stent in infants and children. Pediatr Surg Int 2009;25:191-4.
47. Smith KE, Holmes N, Lieb JI, Mandell J, Baskin LS, Kogan BA, *et al.* Stented versus nonstented pediatric pyeloplasty: a modern series and review of the literature. J Urol 2002;168:1127-30.
48. Sibley GN, Graham MD, Smith ML, Doyle PT. Improving splintage techniques in pyeloplasty. Br J Urol 1987;60:489-91.
49. McMullin N, Khor T, King P. Internal ureteric stenting following pyeloplasty reduces length of hospital stay in children. Br J Urol 1993;72:370-2.
50. Flint LD, Libertino JA. Ureteropelvic junction reconstruction. In: Libertino JA, editor. Pediatric and adult reconstructive urologic surgery. 2nd ed. Baltimore: Williams & Wilkins; 1987; 82-96.
51. Woo HH, Farnsworth RH. Dismembered pyeloplasty in infants under the age of 12 months. Br J Urol 1996;77:449-51.
52. Bayne AP, Lee KA, Nelson ED, Cisek LJ, Gonzales ET Jr, Roth DR. The impact of surgical approach and urinary

diversion on patient outcomes in pediatric pyeloplasty. J Urol 2011;186(4 Suppl):1693-8.
53. Braga LH, Lorenzo AJ, Farhat WA, Bagli DJ, Khoury AE, Pippi Salle JL. Outcome analysis and cost comparison between externalized pyeloureteral and standard stents in 470 consecutive open pyeloplasties. J Urol 2008;180(4 Suppl):1693-8.
54. Smith KE, Holmes N, Lieb JI, Mandell J, Baskin LS, Kogan BA, *et al.* Stented versus non stented pediatric pyeloplasty: a modern series and review of the literature. J Urol 2002;168:1127-30.
55. Chertin B, Fridmans A, Knizhnik M, Hadas-Halperin I, Hain D, Farkas A. Does early detection of ureteropelvic junction obstruction improve surgical outcome in terms of renal function? J Urol 1999;162(3 Pt 2):1037-40.
56. Neste MG, du Cret RP, Finlay DE, Sane S, Gonzalez R, Boudreau RJ, *et al.* Postoperative diuresis renography and ultrasound in patients undergoing pyeloplasty. Predictors of surgical outcome. Clin Nucl Med 1993;18:872-6.
57. Amling CL, O'Hara SM, Wiener JS, Schaeffer CS, King LR. Renal ultrasound changes after pyeloplasty in children with ureteropelvic junction obstruction: long-term outcome in 47 renal units. J Urol 1996;156:2020-4.
58. Park S, Ji YH, Park KH, Han DH, Kim KS. Difference in results of ultrasonography and diuretic renograms after pyeloplasty in children with unilateral ureteropelvic junction obstruction. Korean J Urol 2009;50:596-601.
59. Austin PF, Cain MP, Rink RC. Nephrostomy tube drainage with pyeloplasty: is it necessarily a bad choice? J Urol 2000;163:1528-1530.
60. Woo HH, Farnsworth RH. Dismembered pyeloplasty in infants under the age of 12 months. Br J Urol. 1996;77:449-451.
61. Anderson JC, Hynes W. Retrocaval ureter; a case diagnosed preoperatively and treated successfully by a plastic operation. Br J Urol. 1949;21:209-214.
62. Hussain S, Frank JD. Complications and length of hospital stay following stented and unstented paediatric pyeloplasties. Br J Urol 1994;73:87-89.
63. Arda IS, Oguzkurt P, Sevmis S. Transanastomotic stents for dismembered pyeloplasty in children. Pediatr Surg Int 2002;18:115-11 8.
64. Sutherland RW, Chung SK, Roth DR, Gonzales ET. Pediatric pyeloplasty: outcome analysis based on patient age and surgical technique. Urology. 1997;50:963-966.
65. Persky L, Tynberg P. Unsplinted, unstinted, pyeloplasty. Urology. 1973;1:32-35.
66. Braga LH, Lorenzo AJ, Farhat WA, Bägli DJ, Khoury AE, Pippi Salle JL. Outcome analysis and cost comparison between externalized pyeloureteral and standard stents in 470 consecutive open pyeloplasties. J Urol 2008; 180:1693-1698 .
67. Zaidi Z, Mouriquand PD. The use of a multipurpose stent in children. Br J Urol. 1997;80:802-805.
68. Elmalik K, Chowdhury MM, Capps SN. Ureteric stents in pyeloplasty: a help or a hindrance? J Pediatr Urol 2008;4:275-279.
69. McMullin N, Khor T, King P. Internal ureteric stenting following pyeloplasty reduces length of hospital stay in children. Br J Urol 1993;72:370-372.
70. Ninan GK, Sinha C, Patel R, Marri R. Dismembered pyeloplasty using double ‘J’ stent in infants and children. Pediatr Surg Int. 2009;25:191-19 4.
71. Smith KE, Holmes N, Lieb JI, Mandell J, Baskin LS, Kogan BA, Walker RDIII. Stented versus nonstented pediatric pyeloplasty: a modern series and review of the literature. J Urol. 2002;168:1127-1130.
72. Le TS, Le CT, Le TH, Nguyen TD, Huynh CN, Nguyen TT. Transpelvic anastomotic stenting: a good option for diversion after pyeloplasty in children. J Pediatr Urol. 2011;7:363-366.
73. Wollin M, Duffy PG, Diamond DA, Aguirre J, Ratta BS, Ransley PG. Priorities in urinary diversion following pyeloplasty. J Urol. 1989;142:576-578.
74. Guys JM, Borella F, Monfort G. Ureteropelvic junction obstructions: prenatal diagnosis and neonatal surgery in 47 cases. J Pediatr Surg. 1988;23:156-158.
75. Baniel J, Livne PM, Savir A, Gillon G, Servadio C. Dismembered pyeloplasty in children with and without stents. Eur Urol. 1996;30:400-402.
76. Ahmed S, Crankson S. Non-intubated pyeloplasty for pelviureteric junction obstruction in children. Pediatr Surg Int. 1997;12:389-392.
77. Sibley GN, Graham MD, Smith ML, Doyle PT. Improving splintage techniques in pyeloplasty. Br J Urol. 1987;60:489-491.
78. Reed MJ, Williams MP. Open pyeloplasty in children: experience with an improved stenting technique. Urol Int. 2003;71:201-203.
79. Nguyen DH, Aliabadi H, Ercole CJ, Gonzalez R. Nonintubated Anderson–Hynes repair of ureteropelvic junction obstruction in 60 patients. J Urol. 1989;142:704-706.
80. Bayne AP, Lee KA, Nelson ED, Cisek LJ, Gonzales ET Jr, Roth DR. The impact of surgical approach and urinary diversion on patient outcomes in pediatric pyeloplasty. J Urol 2011;186:1693-1698.
81. Sarin YK, Gupta R, Nagdeve N. Pediatric pyeloplasty: intubated vs nonintubated. Indian J Urol. 2006;22:35-38.
82. Meisheri IV, Kamat TA, Maheshwari M. Pelveureteric junction obstruction stented versus unstented pyeloplasty. J Indian Assoc Pediatr Surg. 2004;9:184-188.
83. Liss ZJ, Olsen TM, Roelof BA, Steinhardt GF. Duration of urinary leakage after open non-stented dismembered pyeloplasty in pediatric patients. J Pediatr Urol. 2013;9:613-616.
84. Eden CG. Minimally invasive Paick SH, Park HK, Oh SJ, Kim HH. Characteristics of bacterial colonization and urinary tract infection after indwelling of double-J ureteral stent. Urology. 2003;62:214-21 7.
85. Ben-Meir D, Golan S, Ehrlich Y, Livne PM. Characteristics and clinical significance of bacterial colonization of ureteral double-J stents in children. J Pediatr Urol. 2009;5:355-358.
86. Arda IS, Oguzkurt P, Sevmis S. Transanastomotic stents for dismembered pyeloplasty in children. Pediatr Surg Int. 2002;18:115-11 8.
87. Castagnetti M, Berrettini A, Cimador M, Sergio M, Rigamonti W, DeGrazia E. Complications of trans-anastomotic externalised stents in open pyeloplasty: infl uence of the method of placement, the duration of stenting, and the associated bladder drainage. Pediatr Surg Int. 2010;26:309-313.
88. Babu R, Sai V. Pelvis/cortex ratio: an early marker of success following pyeloplasty in children. J Pediatr Urol. 2010;6:473-476.
89. Lee YS, Lee CN, Kim MU, Jang WS, Lee H, Im YJ, Han SW. The risk factors and clinical significance of acute postoperative complications after unstented pediatric

pyeloplasty: a single surgeon's experience. J Perdiatr Surg. [Epub ahead of print].
90. Romao RL, Farhat WA, Pippi Salle JL, Braga LH, Figueroa V, Bägli DJ, *et al*. Early postoperative ultrasound after open pyeloplasty in children with prenatal hydronephrosis helps identify low risk of recurrent obstruction. J Urol. 2012;188:2347-2353.
91. Neste MG, du Cret RP, Finlay DE, Sane S, Gonzalez R, Boudreau RJ, Kuni CC. Postoperative diuresis renography and ultrasound in patients undergoing pyeloplasty. Predictors of surgical outcome. Clin Nucl Med. 1993;18:872-876.
92. Amling CL, O'Hara SM, Wiener JS, Schaeffer CS, King LR. Renal ultrasound changes after pyeloplasty in children with ureteropelvic junction obstruction: long-term outcome in 47 renal units. J Urol. 1996;156:2020-2024.