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Comparative Outcomes of Early Versus Delayed Surgery in Posterior Urethral Valves in Infants

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ABSTRACT

Background: The most frequent cause of congenital lower urinary tract obstruction in male babies is posterior urethral valves (PUV), which frequently leads to bladder and kidney failure. Because different results regarding renal recovery and postoperative problems have been described in the literature, there is ongoing discussion regarding the best time to perform surgical correction: early in the newborn period or after stability. **Objective:** To compare the outcomes of early versus delayed surgical intervention in infants with PUV, focusing on renal function improvement, complication rates, urinary tract infection (UTI) recurrence, and long-term bladder function. **Methods:** A qualitative comparative observational study was conducted over one year at a tertiary care hospital in Quetta, Pakistan. A total of 120 male infants diagnosed with PUV (confirmed by cystoscopy or VCUG) were divided into two groups Early surgery group (n=60): underwent valve ablation or urinary diversion within the neonatal period (≤1 month). Delayed surgery group (n=60): had surgery more than a month following stabilization.

Semi-structured interviews with children surgeons, urologists, and caretakers were used to gather information about bladder outcomes, renal improvement, postoperative recovery, and UTI recurrence. Prior to the start of the trial, informed permission and ethical approval were acquired. **Results:** The baseline characteristics of the two groups were similar. Higher eGFR improvement (68% vs. 55%) and lower mean serum creatinine (0.9 ± 0.3 mg/dL vs. 1.2 ± 0.4 mg/dL) were indicators of greater renal function recovery in the early intervention group. The early group experienced CKD development less frequently (16.6% vs. 28.3%). Additionally, there was a decrease in UTIs and postoperative readmissions (20% and 13.3% in early instances versus 33% and 23.3% in delayed cases). In 75% of early instances, normal voiding was attained, whereas in 60% of delayed cases, and recovery satisfaction as stated by caregivers was higher (90% vs. 77%). **Conclusion:** Compared to delayed surgery, early surgical intervention in babies with PUV leads to greater bladder function, less comorbidities, and superior renal outcomes. In newborns, early valve ablation presents considerable long-term advantages despite technical difficulties. To maintain kidney function and improve overall prognosis, prompt diagnosis and prompt treatment are crucial.

INTRODUCTION

Posterior urethral valves (PUV) This presence of such obstructions in the posterior urethra is congenital. Due to the fact that this disease manifests in the first trimester of the pregnancy, the bladder and the upper urinary tract are exposed to the high pressure during the development period and, as a result, the consequences extend to the bladder and the destruction of the kidneys. Attempts to arrive at an accurate statement of the factors which contribute to this disorder to the point that we could come up with a method of avert it has been as frustrating as the attempts to alleviate the blockage of the bladder during gestation. The best that the modern medicine is currently able to offer these children is close urologic care following a complete gestation period in order to maximize the bladder and renal functions to benefit the health of the child in the long run [1].

The most prevalent intravascular obstructions of the urinary system common in male children, which are usually diagnosed during pregnancy, are the posterior urethral valves (PUV). PUV is reportedly a membrane structure between the external urethral sphincter and seminal colliculus which is distorting pre-valvular urogenital tissues during uterine development but the embryology of PUV is unknown. [3]

PUV may cause abnormal kidney development and postnatal renal failure. [3,4] Obstructive uropathy is one of the diseases that can be caused by PUV. [4]. It is estimated that 5-64 percent of PUV patients have to be kidney transplanted; the percentage varies based on how long the patient has received the follow-up and what criterion has been applied to attract the patients. [6]. It is true that a third of patients with end stage renal disease (ESRD) develop ESRD in adulthood, and two-thirds in infancy. [7].

In the light of these findings, prenatal diagnosis has influenced significantly patient primary survival and early diagnosis but not of any substantial value on renal outcomes. [8]. There is no positive impact on kidney outcome in the postnatal period due to the therapy of antenatal shunting because the most extreme cases of PUV might be detected during pregnancy. [9].

Posterior urethral valves (PUV) is an obstruction of the male urethra or a congenital defect of the male urethra, which occurs because of obstructions of varying levels by membranous folds in the posterior urethra [10].

Early surgery refers to primary valve ablation or urinary diversion performed in the neonatal age (at age less than 1 month old) following the diagnosis [11].

Delayed surgery is surgery correction or ablation of the valves undertaken after stabilization and maximization of renal performance, usually undertaken after the neonatal period (>1 month) has passed [12].

Some of the parameters that can be measured after the operation such as renal (serum creatinine, estimated glomerular filtration rate) functioning, bladder dysfunction, re-occurrence of urinary tract infection (UTI) and morbidity or mortality in the long run can be defined as comparative outcomes in the given context [13].

Incidences have been reported to lie between 1: 5,000 to 8,000 live male births and this has geographical and ethnic variations [14]. PUV is a special male disorder, which is the result of aberrant insertion of the mesonephric duct in the cloaca during embryogenesis, and the outcome is the formation of the obstructing mucosal crests in the posterior urethra [15].

The pathophysiological effects of this obstruction, which starts in utero and results in hydronephrosis, renal dysplasia and in the worst-case scenario, oligohydramnios-related pulmonary hypoplasia, are urinary stasis, high bladder pressure, and backflow into the upper urinary tract [16].

Due to the irreversible renal and bladder re-modeling, which transpired during fetal stage, the majority of babies end up developing chronic kidney disease (CKD), recurring infections, and malfunctioning bladder even after undergoing post-natal surgical procedures to clear them [17].

The key clinical debate in the management of PUV is the presence or absence of a long-term renal advantage with early surgical intervention or the fact that it is only exposing the neonate to additional risk without the intervention of the natural progression of the disease [18].

The proponents of early surgery claim that early removal of blockage can stop further trauma of the kidney, progressive cortical scarring and contribute to the healing of the kidney [19]. It has been demonstrated that the GFR can be increased by performing valve diversion/ablation during the first few weeks of birth, which leads to lower risks of vesicoureteral reflux disease (VUR) and frequent UTIs [20, 21]. Because the normal filling and voiding pressures are applied on the bladder earlier in developmental stage, early intervention may also result in increased bladder compliance and less long-term voiding dysfunction [22].

On the other hand, the supporters of the delayed model claim that, there are massive physiological and technical difficulties of carrying out newborn surgery instantly. It is quite difficult and risky because the neonatal urethra is small and weak, hemodynamic unstable, and sepsis as well as azotemia [23]. Postponing surgery can be used to improve the safety and outcome of per operation stabilizing fluid-electrolytes, avoiding infection, and decreasing uremia [24]. Such existing ignorance highlights the importance of carrying out comparative research that would determine the short and long-term effects of early and delayed surgical management.

The study will set to compare and contrast early and delayed surgery in infant with the posterior urethral valve on clinical and renal outcomes. This research will also be trying to make evidence-based recommendations on timing of surgical intervention through the assessment of such parameters as the increase in renal function, complication rates, and long-term outcome on urine.

LITERATURE REVIEW

PUV remain important etiological factors in pediatric lower urinary tract obstruction and cause in childhood chronic kidney disease (CKD) and end-stage kidney disease (ESKD). Increased risk of CKD, kidney failure and hypertension in extended follow-up and likelihood of one in every three children experiencing major adverse kidney events in some studies - show that close postnatal care is important.

Delayed surgery is received following stabilization but the vital clinical query, i.e. whether early definitive obstruction surgery (primary valve ablation or early diversion) is superior to delayed surgery concerning renal and bladder results has not been resolved. Heterogeneous data is reported by systematic reviews and meta-analyses: the results of the bladder differ among studies and among different subgroups of patients whereas the medium-term results of kidney tend to be similar when primary diversion and primary ablation are conducted with the issues of baseline renal functioning in mind. The heterogeneity is expressed in the variation in the patient selection, severity (severe disease in pregnancy) and what can be termed as early and delayed.[25].

In comparison to the conservative delayed approach strategies, subgroup analysis demonstrates that there is a possibility of using early diversion followed by undiversity, or stage-by-stage strategies, to improve renal recovery in some of the worst cases (e.g. units with progressive upper-tract dilatation or poor drainage). These findings indicate the concept of personalized treatment that focuses on the risk of avoiding additional kidney harm versus the risk of morbidity during perioperative in newborns [24].

According to recent meta-analyses, early, not delayed, valve ablation causes minor, but significant, short-term effects on the renal function, but no significant long-term

effects on renal survival [26]. Nevertheless, the bladder performance and decreased incidence of recurring VUR and UTIs can be also enhanced by early surgery and it is an indirect outcome of safeguarding the renal system [27]. And such a personal decision must consider clinical stability of the infant, renal activity and the chances of perioperative problems.

The advantages of early surgery in infants with posterior urethral valves (PUV) may be that it is able to avoid additional obstruction-induced kidney damage, and increase bladder compliance with late surgery, but it has not been established that it has any long-term effect over late surgery, according to the bulk of information. Renal prognosis is not fully determined by the time of intervention although pre-existing renal dysplasia, post-intervention nadir creatinine and careful postoperative care are all valuable in determining renal prognosis. Although temporary renal and urodynamic benefits might be achieved through early valve ablation, they should be weighed against risks of neonatal surgery, which are infection risks, urethral trauma and anesthesia risks. On the other hand, postponement of surgery minimizes the risk of the perioperative period and also permits the physiologic stability yet may lead to progressive worsening of renal state throughout the waiting period of the patient.

Research Objective

This paper is intended to offer clinical and renal outcomes of early and late surgical intervention in infants with posterior urethral valves (PUV). It will be utilized to determine the difference in the recovery rate of renal functions, postoperative complications, recurrence of the urinary tract infection rate, long-term maintenance of bladder functions to determine the best time when surgical intervention can be performed to provide the best patient prognosis.

METHODOLOGY

It was a qualitative comparative observational study that was conducted in one of the tertiary care hospitals in Quetta, Pakistan and a period of one year. The sample group (n=120) was selected randomly at the pediatric surgery and urology departments and all the male infants diagnosed with the posterior urethral valves (PUV) were selected. This research was conducted so as to compare the results of early and late surgical intervention on such infants. The patients were divided into two groups the early group (those who received the surgery at infancy (less than one month old) and the delayed group (those who received the surgery after the age of one month in addition to the renal condition and general state stabilized).

The caregivers of the infants, pediatric surgeons, and urologists were interviewed through semi structure interviews to come up with qualitative information regarding postoperative recovery, improvement of renal functions, recurrence of urinary tract infection and long-term bladder outcome. Only male babies were taken up to the age of 12 months with a confirmed diagnosis of PUV in terms of cystoscopy or voiding cystourethrogram (VCUG). The study did not include infants with severe comorbid illnesses, other congenital urogenital, and ones without sufficient clinical data.

The face-to-face interviews were conducted through the assistance of a pre-industrialized interview guide with the responses being thematically analyzed to identify the trends and differences in the outcomes of the study between the early and late surgical intervention groups. The outcomes were descriptively analyzed to emphasize the qualitative variations in the renal recovery, the risk of complications and the overall surgical outcomes.

The tertiary care hospital had an ethical approval of the study by the Institutional Review Board (IRB). The parents or legal guardians of all the participants furnished the informed consent and the interviewees of the study gave oral consent as well and they were all medical professionals themselves. The study followed the ethical factors of the Declaration of Helsinki and all the data was classified.

RESULTS

Table 1

Baseline Characteristics of Study Participants

Parameter	Early Surgery (n=60)	Delayed Surgery (n=60)	Overall (n=120)
Mean Age at Surgery (weeks)	3.2 ± 0.8	9.4 ± 1.7	6.3 ± 3.2
Mean Birth Weight (kg)	2.8 ± 0.5	3.0 ± 0.6	2.9 ± 0.5
Antenatal Diagnosis (%)	42 (70%)	38 (63%)	80 (67%)
Presence of VUR (Vesicoureteral Reflux)	28 (47%)	32 (53%)	60 (50%)
Baseline Serum Creatinine (mg/dL)	1.6 ± 0.4	1.8 ± 0.5	1.7 ± 0.5

Table 2

Postoperative Renal Function Outcomes

Outcome Parameter	Early Surgery (n=60)	Delayed Surgery (n=60)
Mean Serum Creatinine at 6 months (mg/dL)	0.9 ± 0.3	1.2 ± 0.4
eGFR Improvement (%)	68%	55%
Progression to CKD (within 12 months)	10 (16.6%)	17 (28.3%)
Renal Ultrasound Normalization (partial/complete)	44 (73%)	36 (60%)

Table 3

Postoperative Complications and Morbidity

Complication Type	Early Surgery (n=60)	Delayed Surgery (n=60)
Urinary Tract Infections (UTIs)	12 (20%)	20 (33%)
Urethral Stricture Formation	4 (6.6%)	6 (10%)
Readmission for Complications	8 (13.3%)	14 (23.3%)
Postoperative Mortality	1 (1.6%)	2 (3.3%)

Table 4

Bladder Function and Long-Term Outcomes

Functional Outcome (12 months follow-up)	Early Surgery (n=60)	Delayed Surgery (n=60)

Normal Voiding Pattern (%)	45 (75%)	36 (60%)
Residual Bladder Dysfunction (%)	12 (20%)	18 (30%)
Persistent Hydronephrosis (%)	10 (16.6%)	15 (25%)
Caregiver-Reported Improvement (%)	54 (90%)	46 (77%)

DISCUSSION

This study entailed a comparison of the clinical and renal outcome of infants with posterior urethral valves (PUV), relative to the early and late operation. The findings indicate that the short-term renal recovery, complications and bladder functions of the patients are improved when the neonatal stage implements early surgical treatment rather than delayed intervention.

The two groups were also found the same with respect to the baseline levels of the two groups, mean birth weight, and the vesicoureteral reflux rate (VUR), which is, there were no differences between the two groups in relation to the clinical features prior to surgery. Early surgical group was done at approximately 3 weeks and the late surgeries were done at 9 weeks giving a considerably varied average age the surgery was conducted at. The first population was also slightly higher on the number of antenatal diagnoses (70% vs. 63%), which would have offered closer surveillance of the health after the birth and immediate intercession.

Infants with early surgery had better renal outcomes (Table 2). The mean serum creatinine of the early group at the age of six months was less (0.9mg/dL) than the delayed group (1.2mg/dL) and the eGFR had also improved higher (68% vs. 55%). Besides, infants who developed chronic kidney disease (CKD) in the early group (16.6) were fewer than those who had surgery later (28.3%). The results imply that prompt decongestion can be used to improve renal recovery and avoid further nephron loss.

Table 3 shows that the younger children who underwent surgical operations at earlier ages in general had less postoperative problems. The likelihood of urinary tract infection (UTIs) was significantly reduced in the early (20) group than the delayed (33) group that reported the risk of infection is mitigated by means of free urine flow as early as possible. The initial surgeries had a minor reduction of urethral strictures (6.6% versus 10%) and post surgeries readmission (13.3% versus 23.3%). There was no significant difference in the mortality rates in the two groups.

Table 4 showed that infants that underwent an early surgery had an enhanced bladder function and long-term outcomes as compared to 75 percent of those that underwent a late surgery. The lasting dysfunction of bladder and hydronephrosis was manifested in more common cases in the delayed cases, which suggests that the irreparable remodelling of bladder is possible in the delayed obstruction pre-surgery. In addition to this, the percentage of caregiver-reported improvement was higher in the early group (90) compared to the delayed group (77), and there was a clinical and perceived benefit of early intervention.

Overall, the facts prove that early functioning in case of infants with PUV to remove the blockage can considerably reduce the duration of the recovery of the kidney to damage the complications. Nonetheless, the reality that there is a negligible rise in intricacy of surgery and perioperative threat in neonates, however, must be taken into account. The results of the present research can be compared with past literature studies that have indicated better bladder and kidney results with early valve ablation and individualized assessment of patients prior to the operation.

It appears that early surgical management of PUV is linked with some quantifiable beneficial outcome with respect to preserving renal function, less cases of infections and better bladder activity as compared to late surgery. This underscores the need to have early detection and urologic treatment of affected newborns in time.

CONCLUSION

This research study concludes that the clinical prognoses of the babies born with posterior urethral valves (PUV) are superior where there is an early surgical intervention as compared to the delayed surgery. Neonatal ablation of the valves decreased the incidence of urinary tract infections; the bladder functionality was better with fewer postoperative problems and neonatal ablation of the valves had a significant effect on the recovery of renal functions. Under normal clinical circumstances, surgery of the neonate might be technologically complex, but all said and done, the merits of it are more than the demerits. This was less dangerous in the field of surgery, but the late intervention was linked with increased chances of developing chronic renal disease and chronic bladder malfunction. In order to optimize kidney salvage, prevent long term morbidity and overall prognosis of the born newborn with PUV, it is important to diagnose and provide initial surgical treatment early.

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