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RESEARCH ARTICLE

COMPARISON OF OPEN AND ROBOTIC ASSISTED LAPAROSCOPIC URETERIC RE-IMPLANTATION PROCEDURES IN PATIENTS WITH VESICOURETERAL REFLUX: NARRATIVE LITERATURE REVIEW

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Abstract

Vesicoureteral reflux (VUR) is a prevalent congenital urological disorder that can lead to recurrent urinary tract infections and renal scarring. Surgical intervention, particularly ureteric reimplantation, is often necessary to prevent these complications, with open surgery being the traditional approach. However, advancements in surgical techniques have introduced robotic-assisted laparoscopic ureteric reimplantation as an alternative. This literature review compares the outcomes, benefits, and limitations of open versus robotic-assisted ureteric reimplantation in treating VUR. The evolution of surgical management for VUR has been marked by continuous refinement, from early open surgical techniques to the introduction of laparoscopic and robotic-assisted procedures. While open ureteric reimplantation remains a gold standard with high success rates (ranging from 80.7% to 99.1%), robotic-assisted techniques have gained popularity due to their minimally invasive nature, which leads to shorter recovery times, reduced postoperative pain, and better cosmetic results, especially in pediatric patients. However, the robotic approach is not without challenges, including longer operative times, higher costs, and the necessity for specialized training. Both surgical methods have distinct complication profiles, with open surgery being more prone to wound-related complications and robotic surgery associated with risks like urinary retention and ureteral injury due to the lack of haptic feedback. The choice between these approaches should be individualized, considering the patients specific needs, the surgeons expertise, and resource availability. Additionally, long-term follow-up is crucial for monitoring recurrent UTIs, renal scarring, and other potential complications. The review concludes that while both techniques are effective, the decision should be guided by a comprehensive assessment of the patient's condition and the surgeon's proficiency with the respective technique.

Introduction:-

Vesicoureteral reflux (VUR) is a common congenital urological anomaly, which refers to retrograde flow of urine from the bladder into the ureters potentially causing recurrent urinary tract infections and renal scarring. Vesicoureteral reflux (VUR) occursin about 30% of children presenting with urinary tract infection (UTI)[1]. The

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main goal in treating VUR is to prevent recurrent UTIs and to preserve renal function, the standard treatment of severe types of VUR is surgical intervention, specifically ureteric reimplantation with the traditional approach being the open surgical technique but with the advances in the surgical field the robotic-assisted laparoscopic approach is gaining popularity. This literature review will compare the outcomes, benefits, and limitations of these two approaches.

Historical Background of Surgical Management of VUR

Surgical management of VUR underwent significant evolution since its inception with various techniques that were developed to to improve outcomes and reduce complications.The continuous refinement of these techniques, particularly with the integration of laparoscopic and robotic techniques, has significantly improved the surgical treatment of VUR.

Early Developments:

Ureteral re-implantation was first described by Bovee[2]in a patient with ureteral injury caused by complications from gynecological surgery. In 1952, Hutch[3] introduced ureteral reimplantation as a mean to correct VUR in a patient with paraplegia. This marked the development of numerous ureteral reimplantation techniques for managing VUR.

Progression of techniques:

In 1958, Politano and Leadbetter[4]introduced a unique surgical technique for ureteral reimplantation in which the ureter was mobilized intravesically, creating a submucosal tunnel that allowed the new ureteral orifice to be placed in the original location. The creation of a long submucosal tunnel is particularly beneficial in high grade VUR as it enhances the anti reflux mechanism preventing the ureters from refluxing back into the ureter. However, this technique carries the potential risk for the ureter to kink or obstruct due to the new pathway, additionally there is the risk of causing bowel injury during the procedure due to the required manipulation to create a new hiatus and tunnel.

In the early 1960s, Lich, Gregoir, and Vanregemorter[5,6] introduced extravesical ureteral reimplantation techniques that avoided opening the bladder reducing certain risks associated with opening of the bladder but potentially causing urine retention in children undergoing bilateral ureteral reimplantation due to pelvic nerve injury.

In 1967 and 1978, Glenn and Anderson[7,8]further refined the creation of submucosal tunnels to facilitate a more natural course for the ureter and minimizing the risk of kinking or obstruction.

A significant advancement came when Cohen[9] introduced a transtrigonal submucosal ureteral tunnel technique in 1975 which allowed for the creation of a longer tunnel and was easier to preform. this has been the most widely used method to this day

Introduction of Laparoscopic and Robotic Techniques:

The first introduction of laparoscopic techniques in ureteralreimplantation was in the 1990s. In 1993, Atala et al. [10] performed the first laparoscopic Lich-Gregoir extravesical reimplantation. Similar to open extravesical techniques, this method retained the risk of urinary retention in bilateral VUR cases despite the advantages of minimally invasive surgery.

In 2001, Gill et al.[11] first introduced laparoscopic intravesical ureteral reimplantation, utilizing direct cystoscopic vision to perform Cohen ureteral reimplantation through laparoscopic ports inserted into the bladder. In 2005 Yeung et al.[12] introduced a pneumovesicoscopic technique, using CO_2 gas to inflate the bladder and facilitate the laparoscopic procedure, this method popularity due to its effectiveness and ease to use.

Robotic-assisted surgery further revolutionized the management of VUR which enabled surgeons to perform both intravesical and extravesical antireflux surgeries with enhanced precision. The robotic system provided magnified visualization and improved manipulation, reducing the risk of injury to the pelvic nerve and facilitating complex procedures that were previously challenging with open or laparoscopic procedures

Table 1:- Evolution of of Surgical Management of VUR.

Year	Surgical treatment
1958	Politano and Leadbetter technique for ureteral

	reimplantation
Early 1960s	Lich, Gregoir, and Vanregemorter extravesical ureteral reimplantation techniques
1967 and 1978	Glenn and Anderson ureteral reimplantation
1975	Cohen transtrigonal ureteral reimplantation
1993	First laparoscopic Lich-Gregoir extravesical reimplantation by Atala et al.
2001	Laparoscopic intravesical ureteral reimplantation by Gill et al.
2005	pneumovesicoscopic technique by Yeung et al.

Outcomes and Complications

Success Rates

Both open and robotic-assisted ureteric re-implantation procedures have high success rates in resolving VUR. Open ureteral reimplantation has a well documented high success rate for treating VUR with rates ranging from 99.1% to 80.7%depending on the severity of the condition. The overall patient success rate is 95.1%, and the success rate per ureter is 95.9%.[14]In a study involving 135 childrenwith high grade (IV–V) vesicoureteral reflux who underwent either open ureteral reimplantation or robotic-assisted laparoscopic ureteral reimplantation showed no significant differences in intraoperative or postoperative complication rates.The success rates were 94.0% for the open group and 98.5% for the Robotic assisted group, with comparable long-term clinical success rates (42 months for open and 23 months for Robotic assisted).[15]However, a study done showed that even patients who were treated successfully by ureteric reimplantation during childhood are prone to recurrent UTIs, progressive renal scarring, hypertension and complications during pregnancy, so there is a need for a long term follow up protocol to be established for such patients.[16]

Postoperative Recovery

Postoperative recovery is a critical factor in determining the choice of surgical technique. Children who underwent robotic assisted reimplantation had more favorable outcomes, including shorter time to stooling, fewer days with an indwelling urethral catheter, shorter perioperative drain insertion time, and reduced length of hospital stay.[15]The minimally invasive nature of the robotic approach also results in superior cosmetic outcomes, an important consideration for pediatric patients and their families.

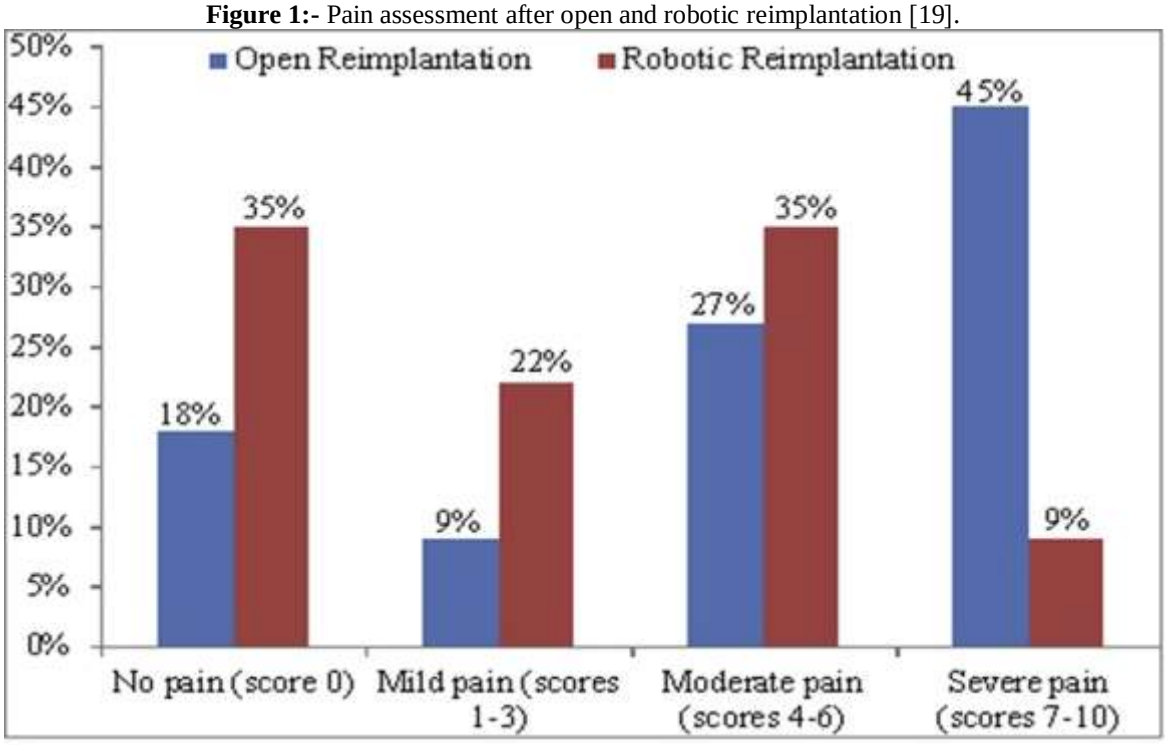
In a study that measured objective pain after ureteral reimplantation found that robotic assisted surgery was associated with lower narcotic requirement and lower intensity of postoperative pain when compared to open ureteral reimplantation. [19]

Complications

Both surgical techniqueshave distinct complication profiles. Open ureteric re-implantation is more prone to woundrelated complications, including infections, pain and potentially unavoidable bladder spasm. In contrast, roboticassisted surgery, while less invasive, can be technically challengingand associated with longer operative time. Additionally, the cost of robotic systems and the need for specialized training are significant considerations that may limit the availability of this technique in some settings.

The complications associated with roboticassisted laparoscopic ureteral reimplantation vary in severity, with urinary retention being the most common and generally considered mild often resolving without any intervention. Urinary retention is a risk in both open and robotic assisted ureteral reimplantation, but may be slightly lower in robotic assisted due to enhanced visualization during surgery. Major complications include ureteral injury, obstruction, or leakage, often caused by perioperative edema or excessive dissection. Ureteral obstruction can sometimes resolve on its own, but persistent issues may require stent placement. The lack of haptic feedback during robotic surgery can contribute to ureteral injuries.[17]A study that was done in 2016 concluded that robotic assisted ureteral reimplantation should be implemented with caution especially in hospitals with limited robotic experience, and outcomes should be closely and systematically monitored.[18]

Figure 1:- Pain assessment after open and robotic reimplantation [19].



Patient Selection and Considerations

Pediatric surgeons should make an effort to select the appropriate surgical management taking into consideration the individual characteristics of the patient such as age, gender, grade of reflux at presentation, status of renal parenchyma, combined bladder and ureteral circumstances, functional status of bladder and bowel and the preference of the childs family.

Surgeon Expertise and Learning Curve

Surgeon expertise and familiarity with the chosen technique significantly influence surgical outcomes. Robotic-assisted surgery requires specialized training, and the learning curve can be steep.Hao G. Nguyen et al. [20]highlights that the volume of procedures performed by the surgeon is a critical factor affecting patient outcomes, high-volume surgeons tend to achieve better outcomes, including shorter hospital stays, fewer ICU admissions, shorter ICU stays, and lower complication rates. Moreover, the study suggests that the favorable outcomes reported in the literature might primarily reflect the experiences of high-volume surgeons which indicates that thebenefitsreported in the literature may not be universally applicable, especially if the procedure is performed by lowvolume surgeon.

Conclusion:-

In conclusion, the management of vesicoureteral reflux (VUR) has evolved significantly, with both open and roboticassisted laparoscopic ureteric reimplantation emerging as highly effective surgical options. Open ureteral reimplantation, with its long history and well-documented success rates, remains a reliable choice for treating VUR, particularly in cases requiring straightforward intervention. However, the advancements of roboticassisted laparoscopic techniques has introduced several advantages, including reduced postoperative pain, faster recovery times, and superior cosmetic outcomes, which are particularly valuable in pediatric patients.

Despite these benefits, the choice between open and robotic-assisted surgery should be carefully individualized, taking into account the patient‘s specific characteristics, the surgeon‘s expertise, and the availability of resources. Robotic surgery, while offering enhanced precision and visualization, requires significant investment in technology and specialized training, which may limit its widespread adoption. Moreover, the success of robotic-assisted procedures is closely tied to the surgeon's experience, emphasizing the importance of a steep learning curve and the potential variability in outcomes.

Ultimately, both surgical approaches have their own strengths and limitations, and the decision should be guided by a thorough assessment of the patient's needs and the surgeon's proficiency with the chosen technique. Long-term follow-up is essential in all cases to monitor for recurrent UTIs, renal scarring, and other potential complications, ensuring the sustained health and well-being of patients with VUR.

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