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Review Article

Current perspectives in robotic assisted pediatric surgery

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ABSTRACT

Minimal access surgery (MAS) in pediatrics, has exponentially expanded in India in the last 2 decades. Since its introduction in the beginning of this century, Robotic assisted surgery (RAS) is being performed for various indications in pediatric population. We reviewed various articles to seek the evidence regarding the indications, benefits, complications and costs of robotic assisted surgery (RAS) in children. The article also compares RAS with conventional surgical techniques both open and laparoscopy with the aim to provide its current and future implications in developing country like India. The peer-reviewed literature was searched for studies that provided evidence of the feasibility and safety of robotic surgery in children and for studies that compared RAS with laparoscopy or open surgery. Review of various studies showed that RAS in children was safe and feasible as compared with traditional laparoscopic and open surgery. However, the advantages of the robotic system were best seen in complex urological procedures and in surgeries involving more of suturing especially in areas which are deep to access. Cost considerations and lack of training centers in India is a major drawback in the current scenario.

Conclusions: Given the advantage of technical refinements in instruments, its precision and accuracy, RAS in children is growing worldwide. Cheaper instruments and more training centers will eventually make robotic surgery cost effective in the near future and RAS may become an alternative to laparoscopy in future.

1. Introduction

The term Robot which means Forced Labour comes from Czech word robota, which was first used in 1920 mainly in an entertainment form.[1] The branch of technology that deals with various aspects of robots is called robotics. The robot in surgery is used as a part of computer integrated surgical system to assist surgeon in performing a surgical process. Although it has been used in other fields of science, its introduction in medical field was in 1985, when Kwoh et al performed neurosurgical biopsies using Puma 560.[2] Later, transurethral resection of the prostate was performed with the same system.[3] The first surgical robot approved by the

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FDA was ROBODOC. In 2000, the da Vinci (Intuitive Surgical, Inc., Mountain View, CA) was approved by United States FDA and it is currently in use worldwide. In this system, the surgeon operates at a console which is ergonomically designed with three dimensional vision.[4] The 7° of freedom of movement and other advantages such as tremor control 7 motion scaling its application in various surgical procedures is gaining momentum. Since its first application in pediatric patients in 2001, a lot of procedures are now being performed with Robotic Assistance.[5] In this article, we are presenting a brief review of different applications of robotics in pediatric surgery worldwide and its current scenario in India.

2. Overview of robotic technology

MAS was first used In 1971 by Gans and Berci for infants and children. Since then, the applications of MAS procedures have increased.[6] With better training and advanced technology, MAS procedures have gained worldwide acceptance in the last century. Various studies have shown that, compared with open surgery, MAS results in reduced operative trauma, postoperative pain, complications, and length of hospital stay, as well as better cosmetics.[7,8] However, there are limitations of MAS, such as the 2-dimensional view of the surgical field, lack of depth perception, reduced tactile feedback, restricted instrument movements, counterintuitive eye-hand coordination, and ergonomically tiring positions for surgeons and assistants. There is also a steep learning curve for training in MAS especially in children. In India a number of pediatric surgical procedures are currently done by MAS.[7,8]

Initially, robotic system was also used for laparoscopic procedures in animal models to verify its feasibility and its applicability in different surgical areas, including general surgery, gynecology, urology, and pediatric surgery.[9] It was not until 2000, that the FDA approved 2 robotic systems, the Intuitive Surgical da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA) and the Zeus Micro Wrist Surgical System (formerly manufactured by Computer Motion, Santa Barbara, CA), for assisting in the performance of specific laparoscopic tasks and procedures in adults and children.[10,11]

Robotic surgery was introduced, in the beginning of this century as a surgeon and patient friendly technique to overcome the limitations of MAS. The robotic interface provides improved vision (3-dimensional), depth perception, and filters tremor.[11,12] Meininger et al published the first pediatric robotic case in 2001, which was soon followed by others.[5,13] Currently, robots are used to perform most procedures in children that can be performed by MAS. The FDA approved da Vinci Surgical System consisting of 3 subsystems, the endoscopic instrument control system, the InSite vision system, and the EndoWrist instruments.[10,11]

RAS is gaining wider acceptance in Pediatric Surgery, like in adult population.[5,12,13] As the working space is limited in children and the abdominal wall is generally thinner, proper positioning of ports is highly important.[12,13] The robotic device used in the pediatric setting employs 12 mm, 8 mm or 5 mm working and camera ports, which lead to very small post-surgical incisions, minimal pain at port sites and an improved cosmetic appearance. EndoWrist 5-mm instruments include needle-holders, scissors, graspers, monopolar cautery instruments, ultrasonic energy instruments, and various disposable and reusable accessories.[14,15]

3. Literature search

Evidence evaluated for this review was obtained from the peer-reviewed journals and pubmed search from 1970 to June 2014. The peer-reviewed literature was searched for studies that provided evidence of the feasibility and safety of robotic surgery in children and for studies that compared RAS with laparoscopy or open surgery. Searches were limited to humans and to English-language articles, using the keywords "robotic surgery," "robotic-assisted surgery," "robot-assisted surgery," "robotic," "robot," "da Vinci Surgical System," "Minimal access surgery," "pediatric", child.

4. Applications and results

Since its first use in Nissen Fundoplication, RAS is used in almost all the applications pertaining to MAS in pediatric populations.[5,12–14] However, its cost effectiveness is justified if used in reconstructive and complex pelvic procedures rather than extirpative surgery.[13,14]

More than a thousand da Vinci system are now been set up across the world.[1] Most are in USA,[1] less than 25 are currently in India (Intuitive Data). Robots are currently used by Pediatric Surgeons, Urologists, Gynecologists, Cardiothoracic and General Surgeons.[1,5,12–14,16] Some of the Indications and Procedures in Pediatric Surgery in which Robotic Assisted Surgeries are performed worldwide are listed in Table 1.

5. Procedures performed

5.1. *Fundoplication*

Both MAS and RAS are used in performing fundoplication for Gastro esophageal reflux disease (GERD) in pediatric population.[5,13] The meta analysis of robotic assisted versus conventional laparoscopic fundoplication in children was published in 2014.[17] According to the analysis of various studies the safety and short-term efficacy is comparable between RF and LF in children.[17] There is insufficient evidence to assess comparative effectiveness for many important procedure specific outcome measures. Higher quality and longer follow-up studies are required.[17]

5.2. *Pyeloplasty*

Pyeloplasty for Congenital Pelvi Ureteric Junction Obstruction (PUJO) is performed by both MAS and RAS in pediatric population.[8,18] Multiple series of laparoscopic pyeloplasty have demonstrated high success rates and low perioperative morbidity in pediatric and adult populations, with both the transperitoneal and retroperitoneal approaches.[8,18] Data on pediatric robot assisted pyeloplasty are increasingly becoming