

Evaluating Technical Feasibility and Surgical Outcomes of Laparoscopic Excision of Abdominopelvic Solid Tumors in Children: A Retrospective Review

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Abstract

Introduction

Minimal invasive surgery for abdominopelvic solid organ tumors in paediatric patients is a growing field. Technical challenges persist despite potential benefits, such as reduced postoperative pain and shorter recovery times.

Materials and Methods

This was a retrospective review of all paediatric patients who underwent laparoscopic excision for abdominopelvic tumors. Parameters such as demographics, tumor histology, tumor location and size, blood loss, operation duration, and early outcomes were analyzed.

Results

Thirty-five patients underwent laparoscopy. The median age was 13 years. Females constituted the majority (29). Tumor sites included the pelvis (n=29), right kidney (n=2), retroperitoneal (n=3), and colon (n=1). The average tumor size was 11 cm. Successful laparoscopic excision was achieved in 32 cases, without postoperative complications, with a mean hospital stay of two days.

Conclusions

Laparoscopic excision is technically feasible for paediatric abdominopelvic solid organ tumors, offering minimal complications. However, further studies are needed to define long-term outcomes.

Keywords

Laparoscopy • Paediatrics • solid organ • tumors • outcomes

Introduction

Children diagnosed with abdominopelvic tumors frequently experience significant morbidity, which may be alleviated through the selective implementation of laparoscopic excision when clinically appropriate [1, 2]. The potential advantages of this surgical intervention are particularly relevant for the paediatric population, for whom a swift return to customary activities is highly sought after. The ultimate goal of this technique is to achieve thorough oncological resection while concurrently minimizing morbidity and ensuring a satisfactory recovery interval. Additionally, laparoscopic excision enhances cosmetic outcomes, which holds considerable importance for young patients and their families [3, 4].

In pediatric patients, the laparoscopic approach for excising abdominopelvic tumors is increasingly viewed as a practical alternative to standard open surgery, offering multiple clinical

benefits, including smaller incisions, reduced postoperative pain, and more rapid healing [3,4,5]. Notwithstanding, the implementation of laparoscopic methodologies for the excision of solid tumors poses distinct technical difficulties, particularly due to the dimensions and anatomical positioning of these tumors alongside the intricate anatomy of paediatric patients [6]. While there are obstacles, progress in surgical technology and practices has broadened the application of laparoscopy for children's cancer care [9, 21]. Nevertheless, the existing data about laparoscopic excision for abdominopelvic tumors in paediatric cohorts remains sparse [7, 8]. Given the relatively limited number of cases and the inherent challenges in executing randomized trials in paediatric oncology, retrospective case analyses provide critical insights into the utilization of this surgical approach.

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This study aims to evaluate the use of laparoscopic surgery in pediatric oncology by analyzing patient demographics, tumor characteristics, and recurrence rates. It assesses the technical feasibility and short-term outcomes of laparoscopic tumor removal in the abdomen and pelvis. The study also examines surgical complications and success rates, particularly in a setting with limited medical resources and delayed patient presentations. Overall, it seeks to contribute to the growing evidence supporting minimally invasive surgery as a safe and effective option in pediatric cancer care.

Materials and Methods

This was a retrospective review of hospital medical records of Paediatric patients diagnosed with abdominopelvic tumors, conducted at the Paediatric Surgical Oncology Department of the Shaukat Khanum Memorial Cancer Hospital and Research Center, Lahore, Pakistan. A total of 538 cases were executed, among which 35 paediatric patients, aged under 18 years, underwent laparoscopic excision of abdominopelvic tumors from November 2022 to October 2024. Data was thoroughly gathered on various aspects such as patient demographics, features of tumors including location and their size, surgical details like the duration, blood loss involved, any complications, thoroughness of the surgical process, and involved margins around the resection, and clinical outcomes comprising of length of hospital stay and early post-operative complications. After initial workup and evaluation through advanced imaging techniques, including computed tomography (CT) or magnetic resonance imaging (MRI), to extensively analyze the tumor's properties and likelihood of metastasis. Patients were discussed in a multidisciplinary team (MDT) meeting and received neoadjuvant chemotherapy. After neoadjuvant treatment and reevaluation of tumor size reduction, patients were subjected to local control or excision of the tumor. In the subsequent MDT meetings, a collaborative decision was reached regarding the administration of adjuvant chemotherapy or radiotherapy based on histopathology.

The surgical interventions were conducted under general anesthesia by a proficient paediatric surgical team. Tumor localization and laparoscopic resectability were established preoperatively utilizing imaging modalities, including CT scan or MRI. Surgical success was operationally defined as the complete laparoscopic resection of the tumor that did not necessitate conversion to an open surgical procedure. Complications were classified as either early occurring within 30 days postoperatively or late, with follow-up data gathered through routine clinic visits.

During the laparoscopic procedure, a standard four-port incision was performed. The configuration included an 11 mm camera port, two 5 mm working ports, and an additional

10 mm port. Gas insufflation was sustained at 8 to 12 mmHg, adjusted according to the patient's size. Initially, a diagnostic laparoscopy was executed to localize any metastatic disease. Small tumors, categorized as being under 5 cm, were removed using the umbilical or 10 mm port incision site. Larger tumors, exceeding 5 cm, required a separate Pfannenstiel incision for adnexal cases and an umbilical incision for abdominal cases, which are typically smaller than 5 cm. Before excision, all tumors were contained within an endo bag to prevent tumor spillage. A wound protector was also utilized on the incisions through which the masses were extracted to avoid the dissemination of tumor cells into the wound.

Results

This investigation examined a cohort of thirty-five pediatric and adolescent patients, with a median age of 13 years, encompassing an age range of 7 to 18 years. The demographic distribution exhibited a marked female predominance, comprising 29 females and 6 males. Such distribution is indicative of the customary gender disparities observed in paediatric tumor presentations, particularly about specific tumor types, including dysgerminomas and various germ cell tumors, which are predominantly prevalent among females.

The primary anatomical site of the tumor was the pelvis, which was implicated in 29 of the 35 cases. Tumors localized in the pelvic region are frequently encountered in paediatric patients with adnexal and uterine tumors, thereby reflecting the malignancies that conventionally develop in these anatomical zones. Other, less often observed tumor sites encompassed the right kidney (2 cases), retroperitoneum (3 cases), and colon (1 case). The dimensions of the tumors exhibited considerable variability, with an average size of 11 cm, ranging from a minimum of 4 cm to a maximum of 14 cm. This discrepancy in size is likely indicative of variations in tumor biology and the duration until diagnosis, with larger tumors possibly signifying an extended interval before clinical manifestation (Table 1).

Surgical interventions for these tumors were predominantly conducted utilizing minimally invasive methodologies, with laparoscopic techniques being used in the majority of instances. The mean intraoperative blood loss was recorded at 70 ml, ranging from 10 to 140 ml, suggesting that the surgical procedures were, in general, well-tolerated. However, there were isolated instances of more substantial hemorrhage, which may be correlated with tumor dimensions, vascularity, or the intricacy of tumor excision. The surgical duration exhibited significant variability, with an average operative time of 140 minutes (range: 67-220 minutes), reflecting the procedural complexity, including tumor location and size, as well as the individual surgeon's expertise. Four cases (12.5%) necessitated

Table 1. Demographics, Tumor Characteristics, Surgical Findings.

Characteristics	(n = %)
Median Age	13 years (Range: 7-18 years)
Gender	
Female	29
Male	06
Tumor Location	
Pelvis	29
Renal	02
Retroperitoneal	03
Colon	01
Tumor Size	Mean: 11 cm (Range: 4-14 cm)
Blood Loss	Mean: 70 ml (Range: 2-140 ml)
Duration of Surgery	Mean: 140 minutes (Range: 67-220 minutes)
Conversion to Open Surgery	4 cases (12.5%)
Tumor Type	(n = %)
Adnexal tumors	
Germ Cell Tumors	24
Granulosa Cell Tumors	02
Uterine rhabdomyosarcoma	03
Pheochromocytoma	01
Adenocarcinoma (Colon)	01
Wilms Tumor	02
Abdominal Rhabdomyosarcoma	01
Abdominal Ewing Sarcoma	01

conversion from laparoscopic to open surgical approaches, frequently due to unforeseen complications such as tumor adherence to adjacent anatomical structures, anatomical challenges, or difficulties in executing precise tumor excision under minimally invasive conditions.

The pathological findings exhibited significant heterogeneity, underscoring the extensive range of malignancies that may present within this paediatric population. Adnexal tumors emerged as the predominant, comprising 26 cases. Within this category, dysgerminomas and mature cystic teratomas were the most frequently observed, with each identified in seven patients. In addition to those, various germ cell tumors like mixed germ cell tumors (4), yolk sac tumors (4), and granulosa cell tumors (2) showed considerable prevalence. These findings are consistent with the recognized tendency for germ cell tumors to develop within the ovaries and other gonadal regions in this specific demographic. Besides the previously listed adnexal tumors, we found some unusual cancers, which include a uterine rhabdomyosarcoma (3) pheochromocytoma

Table 2. Surgical and oncological outcomes.

Parameter	Value
Early Postoperative Complications	None
Hospital Stay	Mean: 2 days (Range: 1-12 days)
Positive Surgical Margins	3 cases
Recurrence	5 cases

(1), an adenocarcinoma of the colon (1), a Wilms' tumor (2), an abdominal rhabdomyosarcoma (1), and an Ewing's sarcoma (1). This variability in pathological findings underscores the paramount importance of accurate tumor classification in guiding treatment modalities and prognostic evaluations.

Surgical outcomes were predominantly favorable (Table 2). Although three cases (9.4%) exhibited positive surgical margins, indicating the potential for incomplete tumor resection, no early postoperative complications were observed. This observation serves as an encouraging indication regarding the safety of these surgical interventions. The typical hospital stay for patients lasted around 2 days, with durations varying from 1 to 12 days, reflecting the differences in recovery times and the complexity of the surgeries performed. Despite the encouraging immediate outcomes post-surgery, a recurrence was documented in 5 patients (15.6%) with a mean follow-up time of 17 months. This rate of recurrence emphasizes the persistent challenge of managing paediatric tumors, wherein long-term surveillance remains essential even after successful surgical interventions.

Discussion

In this cohort, the pathological observations were diverse, underscoring the considerable spectrum of neoplasms that may present within this paediatric population. Adnexal neoplasms represented the most frequently encountered entities, comprising 26 cases. Within this category, dysgerminomas and mature cystic teratomas were the most prevalent, with each type identified in seven patients. Additionally, other germ cell tumors, including mixed germ cell tumors (4), yolk sac tumors (4), and granulosa cell tumors (2), were also significantly represented. These findings are consistent with the recognized tendency for germ cell tumors to develop within the ovaries and other gonadal sites in this specific demographic. Besides these adnexal neoplasms, rarer malignancies like uterine rhabdomyosarcoma were also noted in the pelvis. Other tumors, including pheochromocytoma (1), an adenocarcinoma of the colon (1), Wilms' tumor (2), abdominal rhabdomyosarcoma (1), and Ewing's sarcoma (1). This heterogeneity in pathological findings underscores the importance of accurate tumor classification to inform therapeutic approaches and prognostic evaluations.

The outcomes of this investigation indicate that laparoscopic excision of abdominopelvic solid tumors in paediatric patients is both feasible and generally safe, achieving a high success rate of complete laparoscopic resection [9, 10]. In our results, the conversion rate to open surgical intervention (12.5%) is comparable to other documented studies, suggesting that while the majority of cases can be effectively managed laparoscopically [11], certain tumors may still present challenges that necessitate conversion to open surgery due to their anatomical location and proximity to critical structures and patients safety [12].

The results from this investigation are consistent with those presented by Kim et al., who similarly established that laparoscopic resection for pediatric malignant solid tumors is both viable and safe in selected cases [13]. In their cohort of ten patients, they reported that all tumors were successfully excised laparoscopically without necessitating open conversion or resulting in postoperative complications, thereby supporting our findings regarding the safety and technical viability of laparoscopic methodologies in paediatric populations [13]. Moreover, their outcomes highlighted the absence of local tumor recurrences during a median follow-up duration of 17.3 months, which aligns with our observations of a relatively low recurrence rate, with five recurrences documented within a comparable follow-up period.

In a similar vein, Chan et al. documented a series of 38 patients who underwent minimally invasive surgery (MIS) for tumor resection, demonstrating a successful resection rate of 78.9% utilizing MIS techniques [14]. Their analysis indicated that 30 of 38 patients achieved successful MIS procedures, with only eight necessitating conversion to open surgical techniques. Notably, no postoperative complications were recorded, and all patients exhibited favorable cosmetic outcomes, which emphasizes the advantages of MIS, including diminished postoperative morbidity and improved aesthetic results. Their average operative duration of 171 minutes and the requirement for incision enlargement for specimen retrieval in certain instances also offer significant insights into the technical challenges associated with laparoscopic interventions for pediatric tumors. The absence of recurrences in their cohort, even among those with malignant neoplasms, further substantiates the argument for the oncological safety of MIS in appropriately selected pediatric patients [14].

The predominant classification of tumors within this cohort consisted of adnexal tumors, which is indicative of the relatively elevated prevalence of ovarian and analogous neoplasms among the female paediatric population. The effective management of adnexal tumors through laparoscopic techniques underscores the efficacy of this surgical modality, particularly when considering the merits of minimally invasive surgery in safeguarding fertility and diminishing recovery durations. Tumor varieties, such as dysgerminomas and mature

cystic teratomas, have emerged as the most prevalent, and their favorable responsiveness to laparoscopic intervention is consistent with observations from previous research.

In our results, complete surgical resection, perioperative hemorrhage, and operative time are critical variables in assessing the viability of laparoscopic tumor resection. The average blood loss recorded in this investigation was 70 mL, which is considered acceptable for laparoscopic interventions of this nature and is comparable to the findings in the literature. [15] Moreover, the average duration of the procedure was 140 minutes (range: 67-220 minutes), also falling within the anticipated parameters for intricate laparoscopic oncological operations; however, it demonstrated variability contingent upon the size and localization of the tumors. [15] The learning curve inherent to pediatric laparoscopic oncology is considerable, suggesting that duration may be influenced by both the complexity of the tumors and the surgical team's proficiency.

A major takeaway from this examination is the total absence of early postoperative challenges, implying that laparoscopic operations can be executed safely with reduced morbidity when managed by experienced surgeons. The evidence is backed by the work of Kim and others and Chan and their group, where early complications were absent, indicating that a thoughtful patient selection process paired with careful surgical techniques is vital for risk reduction.[13] The minimal rate of complications following surgery, along with a typical hospital stay of only two days, suggests that this surgical method could yield substantial benefits compared to conventional open surgery, which typically involves longer recovery durations and greater postoperative discomfort [16].

To date, there are no constraints concerning tumor size in the pursuit of Minimally Invasive Resection (MIR). Phelps and team clarified that the optimal volume for Minimally Invasive Surgery (MIS) is to remain under 100 mL, without affecting oncologic fidelity or leading to worse outcomes than open surgeries; these lesions largely represented earlier stages and were of lower-risk types. [9] Our findings reveal tumor dimensions ranging from 4 to 14 cm; these resected tumors exhibited relatively modest sizes and presented no complex anatomical risk factors. Comparable observations have been documented in a recent evaluation of local case series about laparoscopic trans peritoneal radical nephrectomy in paediatric patients with Wilms tumors, in which the authors reported that lesions amenable to MIS were smaller (median volume, 334 mL), of the lower stage, and exhibited favorable histological characteristics.[10] Criteria regarding size that incorporate staging and anatomical risk factors will be necessary for establishing acceptable tumor dimensions for MIS within the context of pediatric oncology.

Nevertheless, the emergence of tumor recurrence in five patients during the follow-up period raises significant considerations regarding patient selection and underscores the

necessity for rigorous follow-up protocols. The phenomenon of recurrence may be modulated by various factors, encompassing the biological characteristics of the tumor, the thoroughness of resection, and the sufficiency of surgical margins [17, 18]. Positive margins were detected in three instances, which accentuates the prospective constraints of laparoscopy in securing clear resection margins, especially in the context of larger or more infiltrative tumors [19]. The assurance of clear margins is imperative for the long-term control of the disease. In situations where this cannot be guaranteed through laparoscopic means, an expeditious transition to an open surgical approach should be considered [20, 21].

This review possesses limitations that merit acknowledgment, notably its retrospective design and the relatively modest sample size. The absence of a control group hinders direct comparative analyses with traditional open surgical methods. Although the follow-up duration is adequate for evaluating early recurrence, it may not capture long-term outcomes, such as overall survival rates and late recurrences, sufficiently. Subsequent prospective studies with larger participant cohorts and extended follow-up periods are essential to validate these findings and further refine the criteria for patient selection in the laparoscopic excision of pediatric abdominopelvic tumors, thereby contributing to the establishment of standardized guidelines for laparoscopic management.

Laparoscopic excision of abdominopelvic solid tumors in pediatric populations represents a viable surgical strategy that confers numerous benefits, including diminished postoperative complications, shortened hospital stays, and favorable cosmetic results. While the majority of cases can be effectively managed via laparoscopic techniques, meticulous patient selection is of paramount importance, particularly for larger tumors or those situated in anatomically complex regions. The occurrence of positive surgical margins in some instances underlines the critical nature of intraoperative decision-making regarding the conversion to open surgical methods to ensure safe and optimal oncological outcomes.

Declaration of Conflict of Interest

The author(s) declare that there is no conflict of interest.

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Author contributions

Conceived and designed the analysis: AB, CD Collected the data: AB, CD, EF Contributed data or analysis tools: NA Performed the analysis: AB, EF Wrote the paper: AB.

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