Original Article

Nephrectomy in Children with Wilms' Tumor: 15 Years of Experience with "Tumor Delivery Technique"

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Abstract

Background: The contemporary surgical approach to Wilms' tumors follows that used in adults with renal cell carcinomas, namely, early occlusion of the renal vessels and then removal of the kidney as an intact mass. For years, the surgical approach at our institution has been different, starting with blunt separation of the kidney from the surrounding tissues, followed by its delivery outside the abdominal cavity while it is only attached to the major blood vessels which are subsequently ligated. We aimed to present this "tumor delivery technique" and evaluate its outcomes. **Materials and Methods:** We retrospectively reviewed medical records of children who underwent nephrectomy for Wilms' tumor using "tumor delivery technique." All procedures were performed by the same team, according to the same surgical principles. **Results:** Between 2000 and 2015, 36 children were operated. Median age was 31 months (interquartile range [IQR]: 6–45 mo), and median maximal tumor diameter was 10 cm (IQR: 8–13.9 cm). Tumors were located to the right side in 47%, left side in 42%, and bilateral in 11%. Twelve children have received preoperative neoadjuvant chemotherapy. Capsular disruption and tumor spillage were documented in 4 cases (11%). **Conclusions:** "Tumor delivery technique" is an easy and safe approach which might reduce the overall complication rates and the incidence of intraoperative tumor spillage.

Keywords: Nephrectomy, nephroblastoma, Wilms' tumor

Introduction

The current therapeutic approach to Wilms' tumors is based on performance of radical nephrectomy with possible adjunctive chemotherapy and/or radiotherapy. The contemporary oncological surgical principles still follow those popularized by Robson in the 1960s[1-3] for removal of renal tumors, in general, namely, early occlusion of the renal vessels, preferably the artery before the vein, and then removal of the kidney (with the Gerota and perinephric fat) as an intact mass. The recommended surgical approach for Wilms' tumor is through a transperitoneal transabdominal incision.[4] The extent of the incision varies with the size of the tumor, which might reach to huge dimensions, and the amount of exposure needed. Following exploration of the abdominal cavity, the colon is reflected medially to expose the renal vessels. For right-sided tumors, the posterior peritoneum can be incised up to base of the mesentery. This allows reflection of the entire colon and the small bowels, which provides excellent exposure of the retroperitoneal vessels. Early ligation of the renal vessels before manipulation is ideal. After the vessels are controlled, gentle manipulation of the tumor should then begin.

This operation is accompanied by considerable complication rates because of deferred diagnosis resulting in considerable tumor dimensions at presentation with adhesions to neighboring organs as well as tissue necrosis and fragility. Moreover, Wilms' tumors are very soft and may easily rupture even following gentle manipulations. Consequently, the intraoperative complications include damage to neighboring organs or blood vessels as well as tumor spillage during the dissection and seeding of malignant cells in the peritoneal cavity.

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For years, the surgical approach at our institution has been somewhat different, starting with transperitoneal blunt careful separation of the kidney from the surrounding tissues, followed by its delivery outside the abdominal cavity while it is only attached to the major blood vessels by the renal pedicle which is subsequently ligated and transected to enable *en bloc* tumor removal.

It has been our impression based on 15 years of experience with this technique that this modification facilitates the procedure and decreases the complication rates. The purpose of our study is to present this technical modification and to evaluate its outcomes.

Materials And Methods

Over the past 15 years, we have been using the below described "tumor delivery technique" for excision of Wilms' tumors. The child is placed in a supine position with a rolled towel under the ipsilateral flank to achieve some extension of the renal area. A wide transverse incision is made, starting from the tip of the ipsilateral 12th rib and extending to the midline, half the way between the xiphoid bone and the umbilicus. For large tumors and depending on the amount of exposure needed, the incision might be further extended to the contralateral side. The peritoneum is then entered through the rectus muscles which are divided with diathermy. The small bowel is reflected toward the contralateral side, and the colon is medially displaced after incision of the white line and careful dissection to preserve the colonic blood supply. The peritoneal attachments to the spleen/liver are divided using a right-angle clamp and cautery, and the ureter is identified and ligated. At that stage, a surgical plane is formed between the posterior aspect of the kidney/renal mass and the musculature of the posterior abdominal wall by blunt careful dissection. Pushing from behind with the whole palm of the hand, the entire renal mass is then delivered through the abdominal wall incision, outside the abdominal cavity, while it is only attached to the major blood vessels by the renal pedicle [Figure 1]. As this manipulation is similar to that applied by the gynecologists for fetal head delivery during cesarean sections, the term "tumor delivery technique" has been found appropriate to describe it. Subsequently, the renal hilum is ligated and transected (either separately or together on a Satinsky clamp), to enable *en bloc* tumor removal [Figure 2].

We retrospectively reviewed all Wilms' tumor cases treated at our medical center and recorded patients' demographic and clinical data as well as tumors' characteristics and dimensions.

Descriptive statistics are given as either numerical values (percentage) or median (interquartile range).

Results

Between the years 2000 and 2015, 36 consecutive children were operated at our medical center for Wilms' tumor. Their demographic and clinical data are summarized in Table 1. Decisions regarding therapeutic regimen were taken on an individual basis, upon presentation in a forum consisted of paediatric radiologists, paediatric oncologists, paediatric surgeons, and paediatric urologists, based on the size and the local extension of the tumor. Many Wilms' tumors look quite massive on preoperative imaging, yet determination of resectability was based on the appearance of the tumor in computerized tomography scan of the chest and the abdomen and the clinical impression of the team based on our accumulated experience.

Patients determined to have unresectable tumors (especially large, seem to locally extend to neighboring organs, etc.) have been referred to neoadjuvant treatment. In accordance, 12 children (33%) have received preoperative neoadjuvant chemotherapy.

No remarkable severe intraoperative or immediate postoperative complications were noted except for capsular disruption and tumor spillage reported in 4 cases (11%) – 3 girls and 1 boy – all right-sided tumors. Yet, no difference in tumor diameter was noted comparing the ruptured tumors with the entire case series. One child has postoperatively developed deep venous thrombosis in the postoperative course.

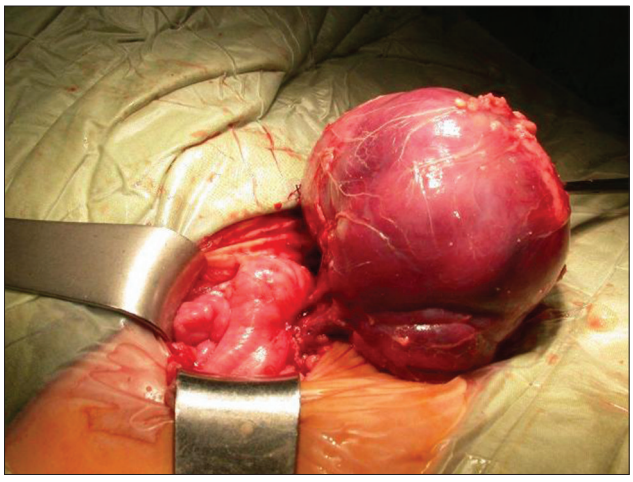

Figure 1: Renal mass attached to major renal vessels

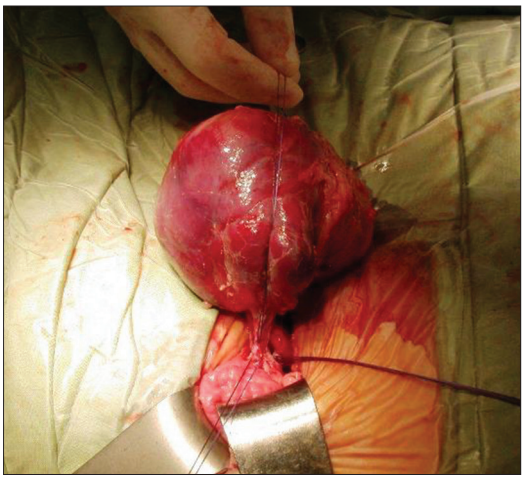

Figure 2: Ligated renal hilus

Table 1: Demographic and clinical data given as either numerical value (%) or median (interquartile range)

Total	36
Boys	19 (53)
Girls	17 (47)
Left	15 (42)
Right	17 (47)
Bilateral	4 (11)
Age (months)	31 (6-45)
Weight (kg)	14 (10-15)
Serum creatinine level (mg%)	
Preoperative	0.5 (0.43-0.5)
Postoperative	0.5 (0.5-0.6)
Maximal tumor diameter (cm)	10 (8-13.9)
Radiation therapy	
Neoadjuvant	1
Adjuvant	11
Chemotherapy	
Neoadjuvant	12
Adjuvant	26

Over a period of 15 years, two children died due to disease recurrence and distant metastases; however, none of the two children had initially experienced intraoperative spillage.

Discussion

The management of Wilms' tumor continues to evolve with two different approaches being conducted in parallel by the National Wilms' Tumor Study Group (NWTSG) in North America and by the International Society of Paediatric Oncology (SIOP) in Europe.[5] In general, the NWTSG favors surgery first while the SIOP advocates the use of neoadjuvant chemotherapy.

In developed countries with advanced radiological imaging and staging as well as high surgical skills, tailoring the therapy to the individual patient is possible with comparable outcomes. However, in developing countries where most patients will present late with Stage III or IV disease, the SIOP approach of preoperative chemotherapy makes surgery safer and achieves good survival results. At present, the excellent survival rates expected for most patients with favorable histology tumors and the decrease in morbidity are in part due to improved chemotherapeutic and radiotherapeutic protocols but also due to improvement in surgical technique.[6,7]

Removing a large renal tumor in a small child is associated with some morbidity. NWTS-4 patients undergoing primary nephrectomy had an 11% incidence of surgical complications.[8] The most common complications encountered are hemorrhage and small bowel obstruction; yet, horrendous complications such as inadvertent ligation of the vena cava, superior mesenteric artery, or the contralateral renal vessels have all been reported.[4] SIOP investigators have reported a lower rate of complications (5%) when nephrectomy is performed after preoperative chemotherapy and shrinkage of the tumor.[5,9] An update on the surgical complication rates following nephrectomy in NWTS and SIOP revealed that there was no overall significant difference in complications (9.8% vs. 6.8%; $P = 0.12$).[10]

The other major responsibility of the surgeon when performing a nephrectomy for Wilms' tumor which is strongly emphasized is complete removal of the tumor without contamination of the operative field.[5] Gentle handling of the tumor throughout the procedure is mandatory to avoid tumor spillage because these patients have a 6-fold increase in local abdominal relapse.[10] The reported 2-year survival after abdominal recurrence is 43%, emphasizing the utmost importance of the surgeon in performing careful and complete tumor resection. Therefore, when spillage is encountered, it is a criterion for Stage III designation with the inevitable need for adjuvant intensive chemotherapy and oftentimes also radiotherapy.[11,12] Nevertheless, the reported spillage rates range between 15.3% and 22% according to NWTSG and 2.2% and 3.2% according to SIOP,[10,11,13,14] probably due to a higher number of NWTS Stage III patients treated initially with surgery (30.4% vs. 14.2%; $P < 0.0001$) as well as the fact that primary chemotherapy leads to shrinkage of the tumor and makes it firmer. In accordance, Barber *et al*.,[15] reviewing their database composed from 41 children, identified 6 cases (15%) with intraoperative tumor spills, of which 3 were Stage III disease and 3 were Stage IV. They also found that the sole significant tumor spill risk factor which is identifiable preoperatively was tumor volume greater than 1,000 cc. In similar, a report of the Children's Oncology Group (COG)[16] has suggested that surgeons should be especially cautious when attempting to primarily resect right-sided and/or large (>12 cm) renal tumors, as each of these factors is associated with an increased risk for intraoperative spillage.

Shamberger *et al*.[17] identified risk factors for local tumor recurrence including poorly differentiated histology, incomplete tumor removal, absence of any lymph node sampling, and tumor spillage. Understandably, while the histological pattern is an inherited feature, the latter three factors are influenced by the surgical skills of the operator and can be improved. Moreover, it has been clearly demonstrated that patients treated by surgeons who perform more nephrectomies annually have fewer complications.[9] Nonetheless, review of the literature reveals that despite it is all over agreed that nephrectomy in this context is a challenging operation, there is an abundance of specific technical surgical instructions and tips which might reduce the complication rates. Therefore, we decided to present the surgical approach which has been successfully used since many years in our institution. We are convinced that the presented technical modification, which is safe and easy, certainly avoids wrong identification and inadvertent ligation of the neighboring blood vessels, provides better exposure and control of the hilum, and prevents injury to other organs. Furthermore, despite the fact that the incidence of tumor spillage in our series (11%) was only somewhat better than the incidence reported by the NWTSG (15.3%–22%) and worse

than the figure reported by the SIOP (2.2%–3.2%), we still find it encouraging since, as a referral center, we have been negotiating with the more complicated cases presenting with remarkable dimensions. From this aspect, larger prospective and standardized studies are needed to further validate this suggestive observation.

Despite these advantages, we acknowledge that the main limitations of the present study are its retrospective nature, the limited number of cases enrolled, and the lack of a control group. From our professional point of view as surgeons, we should admit that "tumor delivery" might be a breath-holding maneuver, thinking about the threat of avulsion of the renal vessels or the vena cava itself, caused by excessive traction imposed by careless mobilization of a large renal mass. However, a support for our argument regarding the possible advantages of the presented technical modification can be eventually found in the COG's protocol which includes a chapter referring to "Surgical Guidelines and Specimen Requirements".[18] Herein, they recommend to routinely expose and ligate the renal vessels before mobilization of the primary tumor, to lessen the chance of hematogenous spread of tumor cells. Yet, they also advise that "preliminary ligation should not be pursued if technically difficult or dangerous".

Conclusions

Wilms' tumor resection using the "tumor delivery technique" is an easy and safe approach which might reduce the overall complication rates and the incidence of intraoperative tumor spillage, in particular. Large prospective and standardized studies are needed to further validate this suggestive observation.

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Conflicts of interest

There are no conflicts of interest.

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