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ORIGINAL ARTICLE

Thoracoabdominal Approach for Giant Tumor Resection in Children

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ABSTRACT

Objective: Surgical exposure has utmost importance in the success of oncological surgery. Traditional incisions may not be adequate for exposure and total excision of the giant tumors. Thoracoabdominal incision favors excision of giant upper abdominal and lower thoracal tumors eliminating telescopic vision and providing excellent exposure of vascular structures. This study is designed to review our institutional experience in upper retroperitoneal tumor excision via thoracoabdominal approach.

Material and methods: The records of children who were operated for neuroblastoma, adrenocortical tumor and Wilms tumor with thoracoabdominal incision between 2015 and 2020 are reviewed retrospectively.

Results: Eleven children underwent surgery via thoracoabdominal approach for neuroblastoma (n=8), adrenocortical carcinoma (n=2), and Wilms tumor (n=1). The female to male ratio was 1.2. The median age at operation was 58 months (IQR, 18-85). Patients with neuroblastoma had total resection (n=6) and near total resection (n=2). *En bloc* resection of tumor with adjacent viscera was performed in two patients with adrenocortical carsinoma. These patients had simultaneous ipsilateral pulmonary metastasectomy. Radical nephroureterectomy was performed in one with giant Wilms tumor. All patients had morphine patient–controlled analgesia for the first 2 days, and then paracetamol was used. Prolonged analgesia was not required in any patient. There was no pulmonary morbidity. Postoperative course was uneventful and the patients were discharged in 5 days (IQR, 4-6) The median follow-up time was 12 months (IQR, 10-18).

Conclusion: The thoracoabdominal incision for difficult upper abdominal tumor is tolerated well by the patients. The enhanced exposure facilitates resection and improves local control. Simultaneous pulmonary metastasectomy can be performed with this incision.

Keywords: thoracoabdominal incision, giant tumor, children.

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INTRODUCTION

The thoracoabdominal incision was first described by Marshall in 1946 for the treatment of combined thoracic, abdominal and renal injuries, the majority of which were combat traumas [1]. Consequently, in 1949, Cute et al reported the advantages of thoracoabdominal approach in excision of giant renal tumors [2,3]. This approach, which provides an excellent exposure to retroperitoneal, abdominal and thoracic areas, has been used in the surgery of tumors in these areas. However, thoracoabdominal incision is rarely used because of the concern that it may lead to respiratory morbidity, postoperative severe pain, and herniation of abdominal viscera through the site of diaphragmatic incision [4].

Surgical exposure has utmost importance to provide total/margin-free excision of an adrenal or renal tumor. Exposure of complex vascular structure of upper abdomen through traditional transabdominal incisions is limited by the neighboring solid organs and the tumor itself. Thoracoabdominal incision eliminates the telescopic phenomenon experienced with conventional abdominal incisions resulting from the need of dissection of tumor deeper and far from the incision.

This study is designed to review our institutional experience in surgical treatment requiring a thoracoabdominal approach in childhood tumors.

MATERIALS AND METHODS

The records of children operated for neuroblastoma, adrenocortical tumor (ACT) and Wilms tumor at our department between 2015 and 2020 were reviewed retrospectively. Age at admission, gender, imaging test results (ultrasonography, computerized tomography, and magnetic resonance imaging), stage of the disease, details of surgical intervention (total excision, gross total excision, visceral excision, lymph node excision and spillage), pain management, early and late complications of surgery, pathologic findings, and outcomes are evaluated. Complications related to thoracoabdominal incision were defined as atelectasis, pneumonia, diaphragm paralysis, wound infection, diaphragmatic hernia and chronic pain. Any radiological or clinical evidence indicating a complication was evaluated.

In the study period 215 patients were operated for neuroblastoma, ACT and Wilm's tumor. In presence of following criteria, the preference of surgeon determined the choice of thoracoabdominal incision:

1. Adrenal tumor with pericaval, periaortic and/or interaortocaval extension.
2. Adrenal tumor in close relationship with other upper intraabdominal solid organs.
3. Tumor involved in abdominal and thoracic compartments.

Surgical technique

Under general anesthesia, the patient is placed in the semilateral position with the affected side elevated and ipsilateral arm well supported. The abdomen and chest are prepared. The incision is carried out between the midline above the umbilicus and obliquely over the abdomen and the 7-8th intercostal space as far as the posterior axillary line, which may be enlarged upon inferior angle of scapula, if necessary (Fig. 1). The incision is deepened through the subcutaneous fat and muscles. When the chest is opened, the diaphragm may be divided radially or circumferentially parallel to its costal attachments while avoiding injury to larger branches of the phrenic nerve. Afterwards, abdominal cavity is opened. For a left-sided tumor, the spleen is mobilized medially with pancreas, stomach, and small intestine. The retroperitoneal space is entered via an incision made lateral to the peritoneal reflection of descending colon. The colon is mobilized medially. For a right-sided tumor, the retroperitoneal space is opened by an incision made lateral to the peritoneal reflection of ascending colon. The colon is mobilized along with the duodenum after Kocher maneuver is applied. The liver may be mobilized, if necessary. After the tumor is dissected peripherally, inferior vena cava (IVC) and aorta are identified, especially in neuroblastoma surgery and the dissection is performed in this respect. In adrenocortical carcinoma surgery, when the dissection is performed peripherally, tearing the fragile tumor capsule should be avoided. Hence, *en bloc* resection may be performed in order to avoid spillage in giant adrenocortical carcinomas. Overall, as the dissection progresses, the tumor is removed

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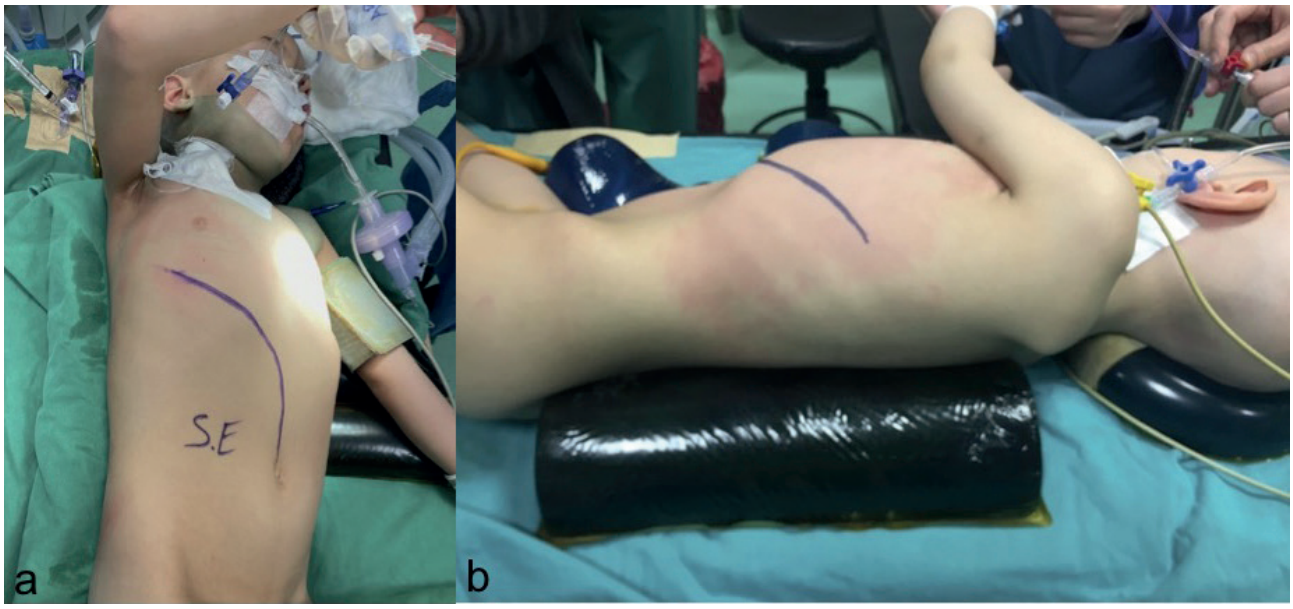

Figure 1. Position for right (a) and left (b) thoracoabdominal approach procedure. The patient is placed in the semilateral position with the affected side elevated and ipsilateral arm well supported. The incision is carried out between the midline above the umbilicus and obliquely over the abdomen and the 7-8th intercostal space as far as the posterior axillary line.

with tunica adventitia of vessels in neuroblastoma surgery.

To provide adequate pain control, morphine patient–controlled analgesia (PCA) was started in all patients, and oral or intravenous paracetamol was added if needed. The pain status of all patients was followed up by the pediatric anesthesia team.

This study was approved by the Institutional Ethical Committee (GO 20-265/17.03.2020).

RESULTS

There were eleven children who underwent surgery via thoracoabdominal approach for neuroblastoma (n=8), adrenocortical carcinoma (n=2), and Wilms tumor (n=1) during the study period. The female to male ratio was 1.2. The median age at operation was 58 months (IQR, 18-85) (Table 1).

Imaging procedures were ultrasonography, computerized tomography, and magnetic resonance imaging. The largest median diameter of tumor was 100 mm (IQR, 65-120) in cross-sectional imaging. Six patients had a close relationship between tumor and retrohepatic inferior vena cava (Fig. 2). Other close relationships between tumor and organs are shown in Table 1. Two patients with adrenocortical carcinoma (ACC) had distant metastasis on the ipsilateral lung (n=2) and liver (n=1). Patients with neuroblastoma had distant metastases (n=3), locoregional disease (n=3) (Fig. 3), and localized disease (n=2).

A right thoracoabdominal incision was used in eight patients, and a left thoracoabdominal incision was used in three patients. Two patients with ACC required an *en bloc* excision [nephrectomy (n=1), splenectomy (n=2), and distal pancreatectomy (Fig. 4) (n=2)] for removal of the tumor. Additionally, two patients underwent metastasectomy for lung metastasis during the adrenalectomy for ACC. Routine retroperitoneal lymph node dissection was not performed in all patients. Only lymph node sampling was performed in three patients with neuroblastoma (n=2) and Wilms tumor. Gross total resection could be performed in six patients with neuroblastoma, and more than 95% resection in two patients with neuroblastoma. Nephroureterectomy was performed in one patient with giant Wilms tumor.

The median duration of operation time was 180 minutes (range, 60 - 270 minutes). The median blood loss was 60 mL (range, 40-600 mL). There was no great vessel injury. The median chest tube removal time was 4 days (IQR, 4-5). The median length of hospital stay was 5 days (IQR, 5-6). Operative mortality was not seen in our series. Internal intercostal nerve bloc was used for all patients. All patients were extubated at the end of the operation and did not need ventilatory support.

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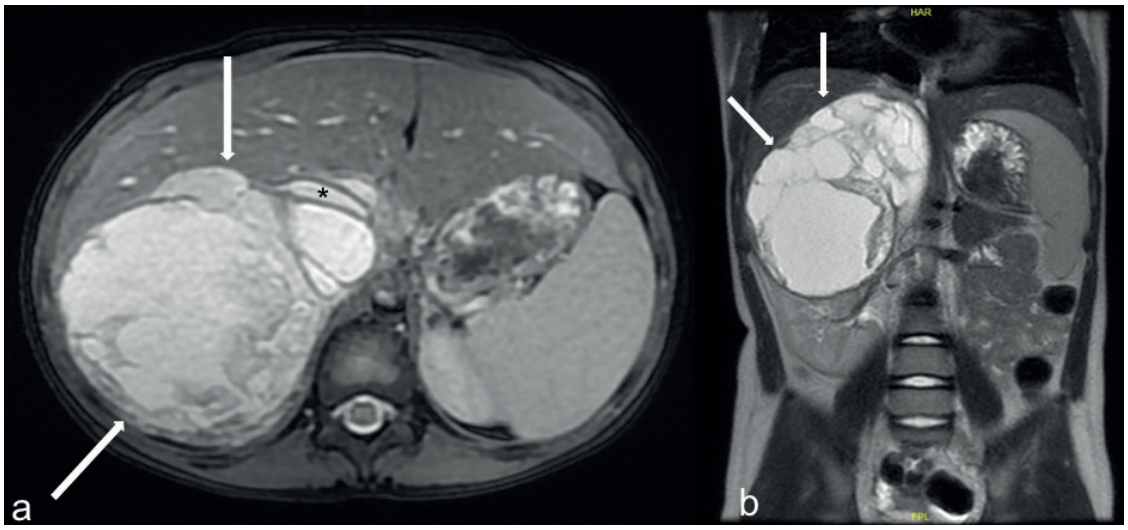

Figure 2. A 6-year-old girl with Wilms tumor. Axial (a) and coronal (b) T2-weighted images show a large heterogenous right renal mass (arrows) and flattened vena cava inferior (black asterisk).

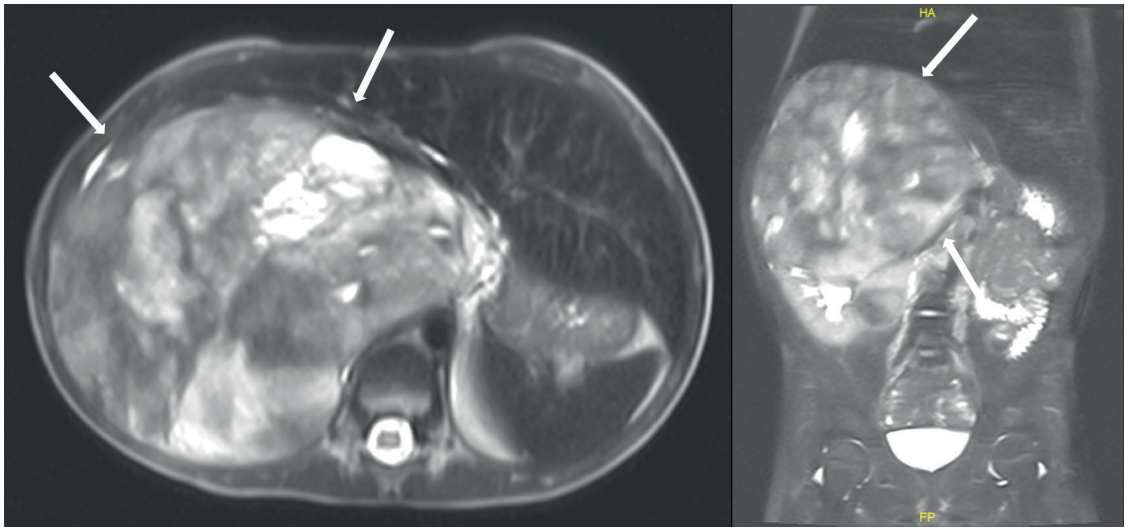

Figure 3. A 5-year-old boy with neuroblastoma. Axial (a) and coronal (b) T2-weighted images show a large heterogenous right suprarenal mass (arrows).

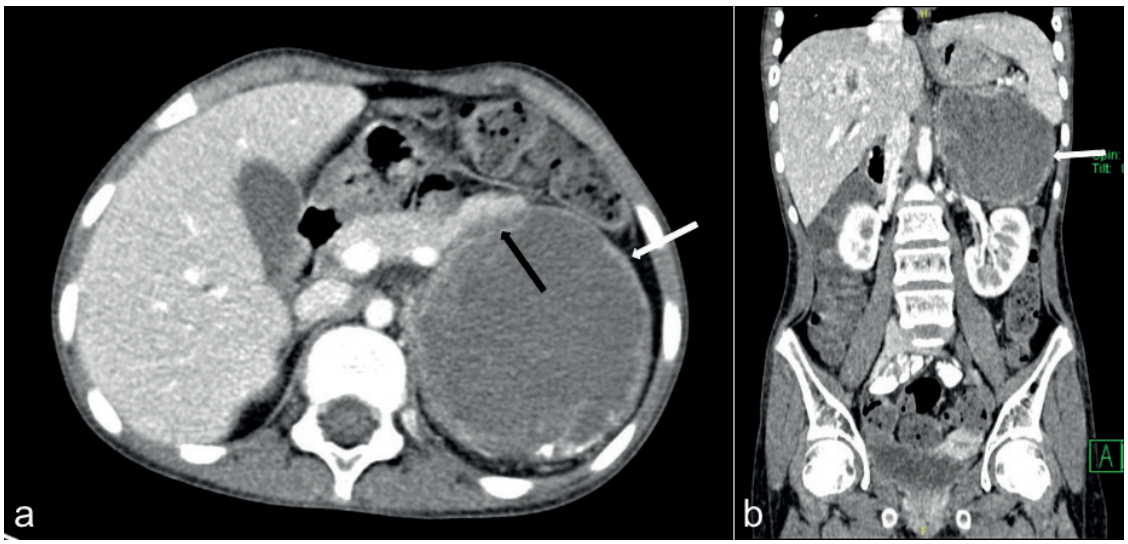

Figure 4. A 12-year-old girl with adrenocortical carcinoma. Axial (a) and coronal (b) contrast enhanced CT images show heterogenous left suprarenal mass (white arrows) and invaded distal pancreas (black arrow).

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Table 1. The clinical characteristics of the patients

The median age (months)	58
Sex	
Male	5 (45%)
Female	6 (55%)
Tumor	
Neuroblastoma	8 (73%)
-L2	*5*
-M	*3*
Adrenocortical carcinoma	2 (18%)
Wilms tumor	1 (9%)
The median size of tumors (mm)	100
Relationships between tumor and organs/vessel	
Aorta	7 (63%)
Vena cava inferior	6 (54%)
Renal vessels	6 (54%)
Hepatic hilus	6 (54%)
Diaphragm	5(45%)
Pancreas	5 (45%)
Kidney	5 (45%)
Superior mesenteric artery	4 (36%)
Celiac artery	4 (36%)
Liver	3 (27%)
Spleen	2 (18%)
Splenic vein and artery	1 (9%)
Stomach	1 (9%)
Duodenum	1 (9%)
Surgery	
Adrenalectomy	6 ((54%)
Paravertebral tumor excision	5 (45%)
Splenectomy	2 (18%)
Distal pancreatectomy	2 (18%)
Lung metastases excision	1 (9%)
Partial diaphragm resection	1 (9%)
Nephroureterectomy	1 (9%)
Outcome	
Disease free	7 (64%)
Remission	4 (36%)

All patient had morphine patient–controlled analgesia (PCA) for the first 2 days, and then paracetamol was used for pain relief. Prolonged analgesia was not required in any patient. There were not any adverse events. The median follow-up time was 12 months (IQR, 10-18). There was no early or late complication related to thoracoabdominal incision.

DISCUSSION

Neuroblastoma is most common malignant solid tumor of childhood. While surgical excision promises survival without chemotherapy in patients with low-risk group, it seems to increase event free survival in intermediate risk and high-risk group patients. Neuroblastoma originates from adrenal glands or sympathetic ganglia [4]. Most common location is retroperitoneum in the upper abdominal region. Involvement of paraaortic, paracaval and aortocaval lymph nodes with the primary tumor creates large irregular masses encasing great vessels and abdominal visceral vasculature. Exposure and protection of these structures from iatrogenic injury is the major challenge of neuroblastoma surgery. Our patients with neuroblastoma had total or near total excision of tumor without an iatrogenic injury. [5].

Basically, while total gross excision is targeted in neuroblastoma, impairment of tumor integrity is unacceptable in ACC [6-10]. The only possible treatment for ACC is R0 tumor excision. *En bloc* resection including adjacent visceral organs may be necessary to avoid tumor spillage. Both tumors are usually operated via traditional transabdominal approach. A giant ACC may prevent the exposure of major vascular structure. The surgical field narrows and deepens as the dissection progresses and telescopic vision phenomenon happens. Thoracoabdominal incision provides an excellent surgical exposure and eliminates this phenomenon. [10,11].

Thoracoabdominal incision is rarely preferred due to concern of pulmonary morbidity and chronic pain in children. After thoracoabdominal incision, no pulmonary morbidity or diaphragmatic was observed during the postoperative period and long-term follow-up. And also, we achieved excellent pain relief with morphine PCA. None of the patients had chronic pain [4].

The Makuuchi incision has been suggested in adult adrenal tumors. However, in the presence of lung metastasis or tumor involved in both thoracic and abdominal cavity, we recommend thoracoabdominal incision to perform *en bloc* excision and metastasectomy [12].

Important limitations of our study are the small number of cases and no comparison group.

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CONCLUSION

The thoracoabdominal incision for difficult upper abdominal tumor is tolerated well by the patients. The enhanced exposure facilitates resection and improves local control. Simultaneous pulmonary metastasectomy can be performed with this incision.

Author contribution

Study conception and design: BA, İRU and SE; data collection: BA and İRU; analysis and interpretation of results: BA and İRU; BA, İRU, FU and SE: draft manuscript preparation; All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Institutional Ethical Committee (GO20-265/17.03.2020).

Funding

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Conflict of interest

The authors declare that there is no conflict of interest.

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