Technological update of the video-endoscopic approach of the diagnosis and staging of tumors in children

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Abstract
The pediatric patient is often difficult to diagnose, especially since the surgical pathology is tumoral. Establishing the histopathological diagnosis of a tumor, staging of a disease and certifying the existence of rare pediatric affections are three of the motives for which the specialists frequently appeal to an exploratory laparoscopy, accompanied by biopsy procedures. The paper presents the laparoscopic biopsy experience of the team from the Department of Pediatric Surgery, “Maria Skłodowska Curie” Emergency Clinical Hospital for Children, Bucharest, Romania. From 2000 to 2013, 95 such procedures were performed (7.76% of a total of 1224 laparoscopic interventions). In many cases, the laparoscopy had an exclusive diagnostic purpose, of whose success has been primarily responsible the targeted biopsy. Current issues are discussed, centered on the most advanced technologies used in minimally invasive approach of pediatric malignancies, referring to the effect of minimizing the possible complications that can arise from this type of intervention. The authors concluded that laparoscopic technique is the method of choice in comparison to other ways of biopsy (classical surgery, ultrasound guidance, tomography, etc.), and it is characterized by a high diagnostic value.

Keywords: laparoscopy, exploratory, biopsy, pediatric pathology.

Introduction
In adult surgery, the first biopsies performed using laparoscopic technique were reported by Conn and Bagley et al. in 1972, while Cognat et al. (1974) published a study including 60 pediatric cases subjected to pelvic exploratory celioscopy, the smallest patient being 6-month-old [1–3].

Minimally invasive technique for the diagnosis and staging is widely used today to assess pediatric patients with gastrointestinal, hepatic or genital malignancies. The association of intraoperative ultrasonography during a laparoscopic inspection net improves diagnostic accuracy compared with conventional imaging techniques and as such must be considered an integral part of staging purpose laparoscopic procedure [4–8]. In addition, laparoscopic examination provides the only way to detect small peritoneal dissemination (1–5 mm) and avoid unnecessary laparotomies in at least 20% of patients [4, 5].

Laparoscopy and laparoscopic ultrasonography are minimally invasive procedures that have recently become important components in the staging algorithm for tumors. Other methods for staging disease include magnetic resonance imaging (MRI) and positron emission tomography (PET). Investigational modalities include peritoneal-fluid cytology and molecular staging techniques [9].

Materials and Methods
In the reviewed 2000–2013 period, the Department of Pediatric Surgery, “Maria Skłodowska Curie” Emergency Clinical Hospital for Children, Bucharest, Romania, 95 laparoscopic biopsies were performed for diverse conditions, representing 7.76% of the total of 1224 laparoscopic interventions performed in children. In most of these cases, laparoscopy had only a diagnostic purposes, for whose success has been primarily responsible the targeted biopsy, performed with mono or bipolar electrocoagulation forceps and later using the LigaSure. For some of these patients, subsequent open curative procedures have been proposed.

Preoperative, in our Department, the majority of tumors currently are diagnosed by ultrasonography (US), computer tomography (CT) and magnetic resonance imaging (MRI). Although we used it less, the peritoneal lavage plays an important role in the detection of intra-abdominal malignancies and remains a sensitive modality. At our institution, laparoscopic-guided liver biopsy and the laparoscopic excision are the preferred techniques for this pediatric population. In each case, the entire peritoneal surface, including the liver and spleen was inspected allowing for the assessment of both diffuse and localized pathology.

A number of other non-surgical diseases, whose treatments require histopathological confirmation, were diagnosed performing laparoscopic biopsy (glomerulonephritis, lupus nephropathy, diffuse hemangiomatosis, miliary tuberculosis, etc.). We used both regular and the small laparoscopic instrumentation kit comprising 2 mm and 3 mm trocars, 5 mm telescope (30°), electrosurgical devices mono/bipolar and LigaSure forceps. Electro-
coagulation technique using radiofrequency (Habib laparoscopic forceps) is undoubtedly the newest and most efficient method of hemostasis for parenchymal organs surgery, but it is still little used in practiced in our country because of the acquisition costs.

**Results**

The majority of patients show no significant findings on examination and the development of specific physical signs usually indicates metastatic disease. The presence of an intra-abdominal mass, hepatomegaly, or ascites is usually due to extensive and incurable disease. The asymptomatic patients diagnosed with M1 disease at laparoscopy avoided a laparotomy and were discharged, usually the day after surgery. In contrast, patients who had M1 disease noted at open laparotomy were hospitalized for an average of seven days. Interestingly, patients diagnosed with M1 disease by laparoscopy did not require a subsequent open procedure for bleeding, perforation, or obstruction. Further, these patients had similar survivals to those of historical controls with M1 disease.

Some of the cases with uncertain preoperative diagnosis, non-surgical, but with a significant gravity and whose histological confirmation was imperative to the therapeutic conduct, benefited of the advantage of video-endoscopic biopsy techniques. Another group of patients included cases that had a bad prognosis of various stages of neoplasic tumors, some complicated, in which histological confirmation was also necessary for establishing the neo-adjuvant cancer treatment, palliative measures. For the latter, curative surgery was virtually excluded from the outset. Most laparoscopic biopsies we recorded for liver tumors (15 cases) and malignant lymphoma (14 cases) (Table 1).

**Table 1 – Laparoscopic biopsy: target organs and histopathological diagnosis**

<table>
<thead>
<tr>
<th>Target organ</th>
<th>Histopathological diagnosis</th>
<th>No. of cases</th>
<th>Total (% of 1224 laparoscopies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>Right hepatic lobe tumor</td>
<td>15</td>
<td>26 (2.12%)</td>
</tr>
<tr>
<td></td>
<td>Chronic liver disease</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diffuse hemangiomatosis</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biliary cirrhosis</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kidney</td>
<td>Glomerulonephritis</td>
<td>10</td>
<td>25 (2.04%)</td>
</tr>
<tr>
<td></td>
<td>Chronic renal failure</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lupus nephropathy</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nephrotic syndrome</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Retroperitoneum</td>
<td>Retropitoneum tumor</td>
<td>6</td>
<td>6 (0.49%)</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>Malignant lymphoma</td>
<td>14</td>
<td>22 (1.79%)</td>
</tr>
<tr>
<td></td>
<td>Inflammatory lymph nodes</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Peritoneum</td>
<td>Carcinomatosis</td>
<td>8</td>
<td>16 (1.30%)</td>
</tr>
<tr>
<td></td>
<td>Miliary tuberculosis</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td>(7.76%)</td>
</tr>
</tbody>
</table>

The value of laparoscopy resides not only in direct visualization of the lesions, but also that permits the practice of targeted biopsy, which allowed microscopic examination of the bioptic fragments (Figures 1 and 2).

Trocars disposition for a laparoscopic liver biopsy will respect the principle of triangulation of specific tools as so: 10 mm telescope through the umbilical trocar, a 5 mm trocar placed in the epigastrium and a second working trocar placed in the right upper quadrant, below the costal margin (Figure 3). Optical trocar insertion should be achieved using the open method and the optical telescope adequate for easy viewing of inaccessible areas (under the diaphragm, splenic box) is that of 30°. This display cement avoids placing additional trocars. The 5 mm telescope is preferred since it is possible to change its position on another trocar during intervention to increase visibility.

The biopsy is usually performed simply, with the help of scissors with which a piece of tumor tissue excised. Specially designed for this purpose, laparoscopic kits include a biopsy forceps, whose jaws are hollow and sharp, so cutting and sampling is performed on the biopsy material. In case of bleeding incidence at the excision placement, hemostasis must be rigorously performed using electrocoagulation or by application of hemostatic films. In lymph node biopsies (Figure 4), we proceed to node dissection, maneuver that involves placing two additional trocars for specific working instruments.

We recommend using as a principle the collecting bags, endo-bag type, for minimized handling of tumor fragments into the peritoneal cavity and to avoid contamination of the trocar wall gates, thereby reducing the risk of neoplastic dissemination. In this attempt, the increasing of the parietal gap is mandatory (Figure 5).

Modern instrumentation (LigaSure, Harmonic and Habib) allows biopsies under rigorous hemostasis, minimizing the risk of bleeding. Special attention will be given to new technologies that revolutionize the hemostasis principles and techniques. A modern machine, very useful and efficient for excision and resection biopsy of parenchymal tissue, is the radiofrequency generator, which uses high waves – RITA (Radiofrequency Interstitial Tissue Ablation). This technology is also based on the principle of a minimally invasive procedure in which an electrode, thin as a needle, is inserted in a liver or spleen lesion, injury that otherwise would be inoperable by using ultrasound guided or CT techniques. Electricity is passed through the electrode to produce heat energy in the cells around it, making a perfect hemostasis. When all cells in the lesion, as well as a sufficient margin cells around them, were heated above the lethal threshold (53°C), the procedure is deemed complete (approximately 11 minutes for an ablation zone, 4 cm length). The active piece of the RITA generator is the laparoscopic Habib clamp, which is equipped with four RF electrodes, that confer safely and rapidity to ablative techniques (Figure 6).

**Discussion**

In the face of a disease whose gravity is suspected by using of the imaging examinations, tactics should focus on gathering reliable information based on histopathological evidence that can be obtained by minimally invasive celioscopic approach. In other words, we aimed to obtain a maximum diagnostic benefit with a minimal surgical trauma, relieving patient suffering by not using laparotomy. New devices and technologies provide an extra comfort for the laparoscopic approach in organ biopsy, reducing the risk of bleeding incidents.
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Figure 1 – (A and B) Hepatic laparoscopic biopsy performed using a mono-polar hook.

Figure 2 – Histopathological pictures from liver tumors. (A) Hepatocellular adenoma – the cords of hepatocytes with variable glycogenation and no significant atypia; of note, unlike architecturally normal hepatic parenchyma, there are no portal spaces or central veins but so-called “floating” vascular channels are present throughout; the absence of a central stellate scar rules out the most common differential diagnosis of this particular lesion, focal nodular hyperplasia; there are no prominent nucleoli and the mitotic activity is not conspicuously increased, indicating a histologically benign lesion. (B) Cholangiocarcinoma* – the lesion demonstrates features of adenocarcinoma including distorted glands and tubular spaces, mucin production, and abundant desmoplasia; the malignant cells are atypical and pleomorphic but are reminiscent of bile duct epithelial cells rather than hepatocytes. HE staining: (A) and (B) ×400. *Pictures courtesy of Elliot Weisenberg, M.D. – Advocate Illinois Masonic Medical Center from USA.

Figure 3 – (A and B) Disposition of the operatory team and trocars for an abdominal superior (left) and inferior (right) exploration.
Regarding liver tumors, the laparoscopic exploration utility, in combination with intraoperative ultrasonography was reported long ago. Laparoscopic-ultrasound is effective and sensitive for the detection of liver metastases and may lead to changes of therapeutic decisions made based on inadequate preoperative conventional imaging: transparietal ultrasound, CT, MRI and cholangio-MRI [10]. Percutaneous video guided needle biopsy is practiced using special devices, and their intraperitoneal locations and tracks are carefully supervised and monitored [11].

Biopsies range is vast, from peritoneal lesions, lymphadenopathy and tumors, and ending with abdominal viscera [12]. Classical Hodgkin’s disease staging performing laparotomy can also be replaced by laparoscopy, thus avoiding lung or peritoneal complications [11, 13].

Lobe and Schropp, performed routinely exploratory celioscopies in children with liver tumors, neuroblastomas and other malignancies, highlighting the possibility of
changing the therapeutic protocol based on intraoperative observations. They reported the case of a teenager in whom the imaging investigations, the diagnosis had been unresetable liver tumor, that included the entire liver, but in whom the laparoscopic exploration revealed a left lateral free segment, allowing successful curative hepatectomy [11].

The introduction of laparoscopy to the diagnostic armamentarium has had a dramatic effect on the staging of gastric tumors. Laparoscopy allows direct visualization of the primary tumor as well as assessment of the liver and peritoneal cavity. Sub-radiological metastatic disease can be identified. Proponents of laparoscopy note that 20% to 40% of patients with clinically localized M0 disease will be up-staged by laparoscopy and have their management changed [14–20]. In this kind of pathology, the laparoscopy is especially sensitive for detecting small peritoneal and hepatic implants that are not detected by CT [14, 15, 18, 21]. The addition of ultrasonography to laparoscopy (laparoscopic ultrasonography – LUS) partially compensates for the lack of tactile sensation and may improve the surgeon’s ability to determine tumor depth and to detect lymph node metastases [22–24].

Particular attention should be paid to the presence of metastatic tumors. The presence of liver metastases and/or peritoneal, signifies often patients inoperability and obliges to palliative interventions. The protocol for the diagnosis of metastases, along with ultrasound, computed tomography, magnetic resonance and various explorations using radioisotopes have to include the laparoscopic biopsy. The collection of biopsy materials for any tumor suspected of being metastatic (tumor diameter 1–2 mm to 1.5–2 cm escape often other imaging tests) or cytological examination carried out in ascites fluid (possibly by peritoneal lavage cytology) are two of the objectives exploratory celioscopy performed for the assessment inoperability and detection of metastases [25].

If the biopsied fragments have a larger size, it is recommended to use the L.A.S.E.R. techniques, electrocoagulation or forceps-type clamps which prevents electrical aggression to the tissue [10]. If the biopsy requires a liver resection then we face the need for a laparoscopic suture similar to that performed in open surgery. Applying L.A.S.E.R. techniques allow these resections without suture [25].

Lobe and Schropp use KTP/532 Laserscope at about 12 to 15 W, or Nd:YAG to approximately 40–60 W to obtain a hemostatic excision of a liver segment. In this way the tissue is not altered by heat and can be easily interpreted by the pathologist. By comparison, electrocoagulation techniques offer the same hemostasis quality but are encumbered by important tissue destructions that make an adequate histopathological examination difficult [11].

Laparoscopic ovarian biopsy is indicated mainly in tumor diagnosis and also in secondary amenorrhea result of Turner’s syndrome. In this respect, the role of bilateral celioscopic gonads inspection maneuver consists in measurement and sampling of tissue for histopathological examination. These targeted biopsies do not trigger significant bleeding. If the maneuver is accompanied by bleeding, this may be controlled by electrocoagulation or laser techniques, without causing injury to the residual ovarian tissue or adjacent structures [26]. Staging ovarian tumors can be performed laparoscopically including peritoneal fluid aspiration, assessment of the intra-peritoneal disseminations, association of omentectomies and liver biopsy. In case of detection of a malignancy, histology of the lesion may warrant additional procedures [27].

### Conclusions

Assimilation need of new technologies in laparoscopic practice arose with the rise of the standard diagnostic and therapeutic measures aimed at eliminating unnecessary surgery, sometimes dangerous for pediatric patients. When after ultrasound and computed tomography the diagnosis remains uncertain or when it is necessary to harvest tissue for histopathological examination, laparoscopy remains the only effective method of approach.

### References


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