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Videolaparoscopic MicroWave Ablation: An innovative technique to treat pancreatoblastoma liver metastases in children

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ABSTRACT

Background: The MicroWave Ablation (MWA) is a mini-invasive technique, based on dielectric heating, used to treat small hepatic tumors or liver metastases in the adult population. The heat-energy is delivered to the target area, causing tumor necrosis, usually under ultrasound or computed tomography guidance. This procedure can be performed as pure percutaneous or with laparoscopic assistance.

Operative technique: A laparoscopic US-guided microwave ablation of the pancreatoblastoma hepatic metastasis was performed in an 11-year old girl. A standard three-port laparoscopic technique was used: the camera port at the umbilicus, and two working port at the upper right quadrant. After adhesiolysis, the intra-operative liver ultrasonography confirmed the pre-operative morphological imaging study and the nodules ablation was performed by using microwaves (MWA), emitted by AMICA probe (Apparatus for MICrowave Ablation; HS Hospital Service, Aprilia, LT, Italy), set at 40 W.

Conclusions: Laparoscopic MWA is a tissue-sparing technique to treat in a mini-invasive fashion unresectable liver tumors or metastases. This technique has been extensively described in adult population, and rarely in children. These preliminary and satisfactory results make MWA promising when treating pediatric patients with malignant primary or secondary liver tumors. Further studies may provide data on its long-term efficacy and safety.

1. Introduction

The MicroWave Ablation (MWA) is a mini-invasive technique, based on dielectric heating, used to treat small hepatic tumors or liver metastases in the adult population [1]. A needle-like electrode (antenna), directly inserted within the nodule, generates a microwave alternating electromagnetic (EM) field, that has a high-frequency oscillation (915–2450 MHz = 915–2450 billion times a second), operating on an imperfect dielectric material, rotating polar molecules, primarily water, that oscillates out of phase, so some EM energy is absorbed and changed to heat. That heat-energy is delivered to the target area, causing tumor necrosis [1,2]. The category of 2450 MHz is the one most commonly employed, whereas 915 MHz can produce deeper penetration, thus potentially creating larger ablation zones [3]. To reach an effective tissue necrosis it is needed at least a temperature of 50–60 °C [4], but is possible to exceed 100 °C.

An US guidance is needed during the whole procedure, which can be performed as pure percutaneous or with laparoscopic assistance.

2. Description of the technique

In April 2020, an 11-year old girl, previously treated in our Department, presented with a pancreatoblastoma liver recurrence. She was originally diagnosed with a pancreatoblastoma arising from the head of the pancreas and with multiple metastases in the right hepatic lobe (S6–S7). Therefore, she underwent three cycle of PLADO regimen, followed by a Traverso-Longmire pancreaticoduodenectomy, a resection of the S6 metastasis and a CT-guided MicroWave thermoablation (MWA) of S7 metastasis. Surgery was followed by the completion of the PLADO regimen.

Eight months later, MRI and CT scan showed a liver recurrence: a 13 mm nodule in S7–S8, close to the area where the CT-guided thermoab-

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lation was performed, and another one of 8 mm in S6. Two cycles of second-line chemotherapy (ifosfamide and etoposide) were attempted without a radiological response (Fig. 1).

Therefore, a laparoscopic US-guided microwave ablation of the hepatic metastasis was planned. The reasons behind the choice of a laparoscopic approach were the need of assessing potential extra-hepatic disease, and the presence of a subcapsular lesion.

A standard three-port laparoscopic technique was used: the camera port at the umbilicus, and two working port at the upper right quadrant. This setting was performed to allow both an optimal position of the ultrasound probe and the adhesiolysis required due to the previous surgery.

A complete exploration of the abdominal cavity allowed to exclude any extra-hepatic recurrence and the intra-operative liver ultrasonography completed the staging, confirming the results of the pre-operative morphological imaging study. The antenna was inserted into the abdominal cavity percutaneously, and it was then set into each lesion with the aid of ultrasound guidance and the triangulation provided by another needle-like probe (Video 1). This needle-like probe was then removed and nodules ablation was performed by using microwaves (MWA), emitted by AMICA probe (Apparatus for MICrowave Ablation; HS Hospital Service, Aprilia, LT, Italy), set at 40 W. The ablation was continuously monitored by the use of the ultrasound probe: the antenna was carefully retracted from the deeper portion of the metastases to the more superficial part. The S7–S8 metastasis was treated with multiple punctures of 7 minutes and 20 seconds of overall duration. The subcapsular metastasis in S6 was treated with a single puncture of 3 minutes and 10 seconds. In addition, another 15 mm subcapsular lesion in S6, at the site of the previous metastasectomy, was also ablated in 1 minute and 50 seconds (Video 2). Eventually, the efficacy of the procedure was verified assessing the complete ablation of all treated nodules with the US probe.

The postoperative course was characterized by a prompt recovery and a low need of analgesic therapy; the patient was discharged home two days later.

The girl underwent to two more cycles of chemotherapy (carboplatin and doxorubicin) as adjuvant treatment, and the MRI scans, at 2, 4, 8 and 12 months, confirmed the absence of suspicious liver nodules. She is currently free from disease one year after the procedure.

3. Discussion

Pancreatoblastoma (PBL) is a very rare solid tumor but represents the most common pancreatic tumor in children under 10 years of age [5]. Prognosis is dismal in metastatic and relapsed cases [6,7]. It occurs at a median age of 5 years and is diagnosed in more than 50% of the cases at an advanced stage, when the tumor is surgically unresectable, either due to local extension beyond the pancreas or to metastatic disease, which usually involves liver, lungs, or lymph nodes [7]. In these cases, a neoadjuvant chemotherapy is indicated before to proceed with a complete surgical resection of the primary and all metastatic sites, if feasible. In case of relapse, second line therapies are often ineffective and surgery may be called in action as a salvage treatment.

In our case, we appealed to tumor MWA, a minimally invasive procedure to treat primary liver tumors and metastases in adult patients. This choice was driven by the need of both sparing liver parenchyma and reducing the occurrence of severe post-surgical adhesions, in a patient with a dismal prognosis and a high probability to develop new liver recurrences, poorly responding to chemotherapy and amenable to further surgery. MWA, in adults with hepatocellular carcinoma (HCC), is indicated when a major hepatic resection is not feasible, due to technical reasons or to patient-related features. Exclusion criteria comprise severe liver dysfunction, and large and/or multinodular tumors (nodule size $>$ 7 cm and number of nodules $>$ 5) [8].

MWA has been applied anecdotally in children with multifocal lesions in different hepatic segments, in which surgery was limited either by the evidence of little healthy liver parenchyma, or tumor proximity to major vascular structures [9]. In a recent study on 5 MWA-treated children with relapsed hepatoblastoma, the median progression-free survival (PFS) and overall survival (OS) after ablation was 9 months and 12 months, respectively [10].

Percutaneous or laparoscopic usually under intraoperative US guidance have been extensively described in adults. They show substantially the same efficacy, but, according to some authors, the laparoscopic approach should be preferred in presence of multifocal disease, subdiaphragmatic location, proximity to high-risk areas (adjacent to large vessels or extrahepatic organs), subcapsular tumors, or if the patient is affected by refractory ascites or severe coagulopathy [4]. The better visualization, which may be provided by a laparoscopic approach, enables to treat more radically tumors, which could be treated only partially through a percutaneous approach. However, the laparoscopic-MWA may result in more procedure-related complications, as its major invasiveness, compared to a pure percutaneous approach, and the higher amounts of energy delivered per treated nodule.

Another well described ablation modality is RadioFrequency Ablation (RFA) [1]. MWA has similar benefits of the RFA, but also several advantages: a greater penetration power (with respect to a high-impedance and a low thermic and electric conductivity), a greater volume of cellular necrosis, higher temperatures possibly delivered to the target lesion and a minor heat-sink effect. However, this increases the risk of collateral injury to adjacent non-target organs or tissues. Furthermore, a procedure time reduction is allowed by MWA, which allows treating larger and/or multiple lesions in a single session [11].

The complications of MWA, due to the antenna placement, thermal injury or approach-related, are similar to those of RFA, and may include: fever, haemoperitoneum, organ perforation, tumor seeding along the antenna's entry site, pneumothorax, pleural effusion, bile ducts stenosis, liver abscess, liver failure and portal thrombosis [12].

Tumors smaller than 3 cm are efficaciously ablated by the use a single antenna, inserted in the deepest tumor part under the ultrasound guidance. Bigger tumors may request the antenna to be inserted in different portion of the nodules, or either by simultaneous insertion of multiple antennas: nevertheless, the ablation of tumor measuring 3–5

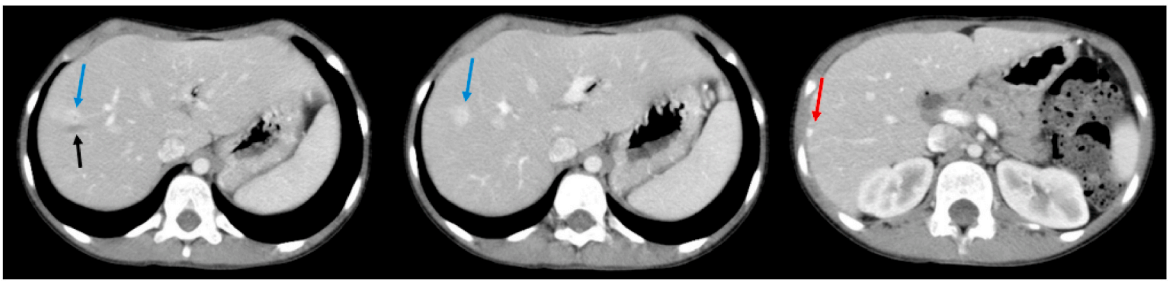

Fig. 1. Contrast-enhanced CT scans showing the S7–S8 metastasis (blue arrow) and near the signs of the previous thermoablation (black arrow), and the subcapsular S6 metastasis (red arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

cm gives significantly lower results, and much less satisfying when treating lesions larger than 5 cm [13]. In order to obtain a complete necrosis of the nodule (which could be compared to a surgical complete resection), it is necessary extend the ablation 5 mm beyond the tumor's margins. In this light, it is easy to understand how the intraoperative US scan assume importance when properly performed both before and after the ablation.

Laparoscopic MWA is a tissue-sparing technique to treat in a minimally invasive fashion unresectable liver tumors or metastases. This technique has been extensively described in adult population, and rarely in children. These preliminary and satisfactory results make MWA promising when treating pediatric patients with malignant primary or secondary liver tumors. Further studies may provide data on its long-term efficacy and safety.

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Consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

Authors disclaimer

All authors attest that they meet the current ICMJE criteria for Authorship.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.epsc.2021.101876.

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