Intraoperative Ultrasound Assistance for Excision of Impalpable Musculoskeletal Soft Tissue Tumors

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Abstract

Intraoperative ultrasonography is a useful tool for the detection and extirpation of liver metastases, breast masses, and melanoma. However, the efficacy of this technology in intraoperative localization and resection of small soft tissue tumors has not been addressed. The purpose of this study is to report on the efficacy of intraoperative ultrasound assistance in excising impalpable musculoskeletal soft tissue tumors.

Twenty-two soft tissue tumors <3 cm (range, 0.7-3 cm) were resected with intraoperative ultrasound assistance. All tumors were localized in the deep panniculus, fascia, or muscle. Surgical time and length of incisions was recorded in all the cases. Intra- and postoperative reregistration was made to confirm the tumor resection. Ultrasound assistance was successful in obtaining an accurate localization in all treated cases. Mean surgical time was 30 minutes (range, 13-87 minutes). Average incision length was 5.7 cm (range, 2.5-10.6 cm). Reregistration allowed intraoperative confirmation of the adequacy of the excision. The procedure allowed recognized and excised additional nodules not previously diagnosed in 3 cases. Postoperative echography done in all patients confirmed complete extirpation of the tumors, and histopathology confirmed adequate margins obtained.

Intraoperative ultrasound can be used as an efficient tool to localize and treat impalpable small soft tissue tumors.

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Ultrasonography has been established as a useful method to evaluate soft tissue masses, especially differentiating cystic from solid masses. Combined color and power Doppler ultrasound, as well as spectral wave analysis, may enable assessment of vascular architecture and altered flow in musculoskeletal tumors. In addition, when the lesion is deep or near vessel bundle, it is possible to use ultrasonography to guide a needle biopsy.

Intraoperative localization of deep and small soft tissue tumors can be difficult and may involve wide resection of the surrounding normal tissue, resulting in unnecessary soft tissue excision or inadvertent neurovascular injuries. Intraoperative ultrasonography is a useful tool for the detection and extirpation of liver metastases, breast masses, and melanoma. However, the efficacy of this technology in intraoperative localization and resection of small soft tissue tumors has not been addressed.

The purpose of this study is to report on the efficacy of intraoperative ultrasound assistance in excising impalpable musculoskeletal soft tissue tumors.

**Material and Methods**

Between January 2007 and June 2010, we performed a prospective analysis of 12 consecutive patients with 22 impalpable musculoskeletal soft tissue masses resected with intraoperative ultrasonography (Table). All tumors were localized in the deep panniculus, fascia, or muscle and were <3 cm (range, 0.7-3 cm). Seven women and 5 men had a mean age of 41 years (range, 16-62 years). All resections were performed with no previous biopsy. All nodules were not clinically palpable before and after incising the skin in all cases.

Toshiba Xario Prime Ultrasound (Toshiba Medical Systems Europe, Zoetermeer, Netherlands) was used to perform pre- and intraoperative real-time, B-mode ultrasonographic examinations. All examinations were performed by 1 radiologist (A.R.) single-handed using a 12-MHz linear array probe. Imaging modalities were used to detect soft tissue masses and to assess their location and resectability.

The surgical technique consisted of 5 steps. A preoperative echography was performed to detect the soft tissue mass and assess its location (with a skin mark) (Figure 1). Then, through a minimal invasive approach (Figure 2), we re-located the mass with intraoperative ultrasonography (Figure 3) and performed the tumor resection (Figure 4). After mass extirpation, we confirmed complete resection with intraoperative ultrasonography and with an ultrasound control of the piece in the back table (Figure 5).

To report the efficacy of the method, we recorded surgical time in all cases, and all resected tumors were histologically analyzed to confirm complete resection.

**Results**

Of the 22 tumors, intraoperative ultrasonography was successful in obtaining an accurate localization in all treated cases. Preoperative magnetic resonance imaging (MRI) diagnosed 1 nodule each in 2 patients and 3 nodules in another patient (3 local recurrences of a chondrosarcoma, giant cell tumor, and malignant schwannoma), and with intraoperative ultrasonography assistance we found and resected the nodules (Table). Also, 3 nodules were found in 1 patient with intraop-
ervative ultrasonography after a metallic implant in the affected thigh produced distortion of the preoperative MRI.

Mean surgical time was 30 minutes (range, 13-87 minutes). Average incision length was 5.7 cm (range, 2.5-10.6 cm).

Postoperative echography performed in all patients confirmed complete extirpation of the tumors. Histopathology confirmed complete tumor resection with adequate margins.

**DISCUSSION**

The modern approach to diagnosing and treating soft tissue tumors requires individual strategy and is mostly dependent on diagnostic tools. The correct diagnosis determines further treatment strategy. Ultrasonography is a valuable screening tool, but other modalities should be used to verify initial diagnosis. The majority of authors indicate that the most accurate methods of detection and evaluation of soft tissue lesions are MRI and plain radiographs. There is still a group of patients who may undergo ultrasonography to differentiate solid and cystic tumors and for guiding a fine-needle biopsy.

Some patients may have a small, deep, impalpable mass that is difficult to surgically resect due to its size and location (Figure 6). Intraoperative ultrasonography has been reported to be a useful tool in locating and resecting small, deep tumors located in other organs like the liver. However, the efficacy of this technology for small musculoskeletal soft tissue tumors is still largely unknown.

This study has some limitations. Due to the small number of patients, statistical analysis was not useful in identifying different factors like sensibility and specificity of the method, resulting in a low power analysis. Also, our results should be considered preliminary, and larger patient numbers may be necessary. Another limitation is the differences in size and location of the primary tumor that makes a heterogeneous population with a different type of resection. Another relative disadvantage of the method is that a radiologist or surgeon trained in intraoperative ultrasonography, and the equipment itself, is needed for this surgical procedure. Despite this relative disadvantage, the equipment is something common in any health institution; this means that with correct preoperative organization, this procedure can be accessible and helpful.

All procedures were performed with no previous biopsy. Even when 5 of the 12 patients had a previous sarcoma diagnosis, we performed all resections through a minimal surgical approach due to intraoperative ultrasonography assistance. Intraoperative ultrasonography helps to locate the lesion more accurately, avoiding unnecessary major surgical approaches and allowing the surgeon to perform a resection with minimal local contamination. In case of an unplanned resection of a soft tissue sarcoma, the reoperation can be less aggressive without modifying the patient prognosis.

The efficacy of the procedure was confirmed due several factors. These include

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Primary Diagnosis</th>
<th>Tumor Location</th>
<th>No. of Tumors</th>
<th>Surgical Time, min</th>
<th>Incision Length, cm</th>
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</thead>
<tbody>
<tr>
<td>1/M/53</td>
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<td>Recurrent LMS</td>
<td>Thigh</td>
<td>3</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>4/F/56</td>
<td>Recurrent MS</td>
<td>Arm</td>
<td>1</td>
<td>17</td>
<td>2.9</td>
</tr>
<tr>
<td>5/M/30</td>
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<td>Pelvis</td>
<td>2</td>
<td>87</td>
<td>10.6</td>
</tr>
<tr>
<td>6/M/28</td>
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<td>20</td>
<td>6.5</td>
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<tr>
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<tr>
<td>11/M/62</td>
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<tr>
<td>12/F/35</td>
<td>Melanoma</td>
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<td>25</td>
<td>5</td>
</tr>
</tbody>
</table>

**Abbreviations:** CS, chondrosarcoma; FS, fibrosarcoma; GCT, giant cell tumor; LMS, leiomyosarcoma; MS, malignant schwannoma.

Figure 6: MRI of a patient with small, deep, impalpable mass, which may be difficult to surgically resect because of the size and location (A). Intraoperative ultrasonography locating the same mass before resection (B).
short surgical time (mean, 37 minutes; range, 14-91 minutes), probably related to the faster tumor location; and the fact that intraoperative ultrasonography detected new soft tissue lesions in 3 patients and influenced surgical strategy. In the same cases, MRIs were distorted by the presence of a metal prosthesis or previous surgery scars, and in these situations, intraoperative ultrasonography can help find new small masses. Lastly, postoperative echography and histopathology analysis confirmed complete extirpation of the tumors. This outcome confirms the value of intraoperative ultrasonography for the treatment of small, impalpable soft tissues tumors.

REFERENCES


