Pre-operative transarterial embolization of musculoskeletal tumors.

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Authors: A. Bangaragiri¹, T. A. J. Urlings¹, L. Sum¹, S. Wong², A. Gogna¹, C. W. Too¹, N. K. Karaddi Venkatanarasimha¹, M. H. Tan¹, K. H. Tay¹, B. S. Tan¹; ¹Singapore/SG, ²London/UK
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Aims and objectives

1. To assess the safety of arterial embolization of musculoskeletal tumours prior to the surgery.

2. To assess technical success (embolization > 70% of feeding vessels) of musculoskeletal tumour embolization prior to surgery.

3. To assess the clinical success described by blood loss and need for blood products during and after surgery following embolization and to compare this with available literature.

Methods and materials

Study population:

This study was approved by our institutional review board, and the requirement for informed consent was waived. We retrospectively reviewed medical records, including radiology, histopathology, anaesthesia and surgical reports, of 12 patients who had undergone preoperative embolization of a musculoskeletal tumour followed by surgical intervention at our institution between June 2011 and July 2015. Indication for preoperative embolization were determined by a single operating surgeon. Demographic data were collected from medical records (Table 1).

Tumour characteristics:

Diagnosis of tumour was confirmed by biopsy prior to surgery or histopathology report on surgical specimen resected. Other tumour characteristics were determined by pre-operative MRIs and specimen resected. Different types of tumours treated were: metastatic thyroid carcinoma 2, spindle cell sarcoma 1, chondrosarcoma 1, osteosarcoma 1, solitary fibrous tumour 1, metastatic liposarcoma 1, chordoma 2, giant cell tumour 1, de-differentiated liposarcoma 1 and leiomyosarcoma 1. Tumour were located in the long bones 2, pelvic bones 3, vertebral column 3 and soft tissue 4. The longest axes of the tumours range from 8.3 cm up to 20.8 cm with a mean of 12.4cm. (Table 1).
Pre-operative trans-arterial embolization:

All procedures were performed in the interventional radiology centre of the Singapore General Hospital. All the procedures were done by 3 experienced interventional radiologists. CT angiography or MRA was done before the treatment in all patients to identify possible arterial feeders. Vascular access in all patients was obtained via the common femoral artery using a 5 or 6 Fr sheath. The different feeding arteries were selectively embolized using a co-axial system. All embolizations were done using polyvinyl alcohol particles (Contour, Boston Scientific) 150-250, 250-355 or 355-500 microns. In two patients (patient 9 and 10) this was combined with gelfoam and in two patients this was combined with microcoils (patient 7 and 8). The number of branches embolized ranged from 2 to 5 feeders. The angiography images were reviewed to assess technical success (>70% devascularisation after embolization). Medical records were reviewed for complications: vascular access complications (false aneurysms, AV fistula or hematoma), vascular complications (rupture, thromboses or dissection), non-target embolization or post embolization syndrome. (Table 2)

Surgery:

All procedures were done by one experienced orthopaedic surgeon in Singapore General hospital. All tumours were resected except for patient 7 and 10. In patient 7 a laminectomy was done for decompression and tumour biopsy. In patient 10 curettage of the tumour was done. The following data before, during and after surgery were collected from medical records: Interval time of embolization to surgery, estimated blood loss during surgery, number/amount of red blood cell transfusions needed, pre- and postoperative haemoglobin level (Table 3).

Results

Table 1: Patient and tumour characteristics

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Tumour Size (AP X CC X Transverse) cm</th>
<th>Location</th>
</tr>
</thead>
</table>

Page 3 of 31
<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Size</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>52</td>
<td>Female</td>
<td>Metastatic thyroid follicular carcinoma</td>
<td>13x7.5x7.5</td>
<td>Left proximal femur</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>Male</td>
<td>Spindle cell sarcoma</td>
<td>5.5X16X5.6cm</td>
<td>Left groin/iliopsoas</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>Female</td>
<td>Chondrosarcoma</td>
<td>12x9x3 cm</td>
<td>Right iliac chondrosarcoma</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>Male</td>
<td>Osteosarcoma</td>
<td>18x18x9 cm</td>
<td>Left iliac bone osteosarcoma</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>Male</td>
<td>Solitary fibrous tumour</td>
<td>6.9X5.8X9.4</td>
<td>Left infraspinatus muscle</td>
</tr>
<tr>
<td>6</td>
<td>66</td>
<td>Female</td>
<td>Metastatic thyroid follicular carcinoma</td>
<td>9.6X13.2X9.4</td>
<td>Left femur</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>Female</td>
<td>Metastatic liposarcoma</td>
<td>8.3X6.5X8.2</td>
<td>T9 spinal metastasis</td>
</tr>
<tr>
<td>8</td>
<td>54</td>
<td>Male</td>
<td>Chordoma</td>
<td>15.7X15.3X20.8</td>
<td>Sacrum</td>
</tr>
<tr>
<td>9</td>
<td>59</td>
<td>Male</td>
<td>Chordoma</td>
<td>9.9X9.6X18</td>
<td>Sacrum</td>
</tr>
<tr>
<td>10</td>
<td>16</td>
<td>Female</td>
<td>Giant cell tumor</td>
<td>6.3X9.3X8.5</td>
<td>Right hemipelvis gaint cell tumor</td>
</tr>
<tr>
<td>11</td>
<td>64</td>
<td>Male</td>
<td>Differentiated liposarcoma</td>
<td>8.3X12.1X8.8</td>
<td>Left iliopsoas muscle</td>
</tr>
<tr>
<td>12</td>
<td>58</td>
<td>Male</td>
<td>Leiomyosarcoma</td>
<td>12.0X12.1</td>
<td>Left proximal thigh soft tissue</td>
</tr>
</tbody>
</table>

*Table 2: Intervention procedure details.*
<table>
<thead>
<tr>
<th>Case No</th>
<th>Agents</th>
<th>Size (micron)</th>
<th>Branches</th>
<th>Complication</th>
<th>Technical success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PVA</td>
<td>355-500</td>
<td>Medial, lateral, medial circumflex femoral</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>PVA</td>
<td>355-500</td>
<td>Branches of profunda and common femoral artery</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>PVA</td>
<td>355-500</td>
<td>Right iliolumbar and superior gluteal artery</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>PVA</td>
<td>355-500</td>
<td>Left superior gluteal artery</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>PVA</td>
<td>355-500</td>
<td>Branches from left axillary artery</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>PVA</td>
<td>355-500</td>
<td>Branches of profunda and superficial femoral artery</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>PVA + micro coils</td>
<td>250-355; 3-4mm</td>
<td>Right T7-T10, T7-9 intercostal arteries</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>PVA + micro coils</td>
<td>355-500; 2mmX2, 4mmX1</td>
<td>bilateral lateral sacral artery, left small branch of superior gluteal artery</td>
<td>-</td>
<td>Yes</td>
</tr>
</tbody>
</table>
In the study period 12 patients (7 males and 5 females; median age 53 years) were treated with arterial embolization before surgical treatment of a musculoskeletal tumour. Three of the patients had more than one session of embolization. Two of the patients (patient 2 & 6) had a two stage embolization procedure performed within 5 days. One of the patient (patient 10) had previous embolization one year earlier, however no surgery was performed then.) The patients underwent surgery in 1-7 days after the embolization procedure. Technical success was achieved in 92% (11/12) patients. The average blood loss was 536 ml (N=9; range 0-1500ml). PRBC during surgical procedure was given in 50% (6/12) of the patients. After the surgical procedure PRBC were given in 50% (6/12) of the patients. The mean volume of PRBC given during the surgical procedures was 426ml ml (Range 300-617 ml) for these 6 patients. The mean volume of PRBC given after the surgical procedures was 650ml ml (Range 300-1200 ml) for these 6 patients. The average drop in haemoglobin after the surgical procedure was 1.4 gm/dl (range -4.2 to +5.3). One complication occurred without clinical sequelae, dissection of one of the feeder vessels in case 11.

Discussion:
Musculoskeletal tumours present variably with pain, loss of function, as fractures or incidentally (1). The management of patients with such tumours is often complex; multiple specialties including radiology, orthopaedic surgery, general surgery, neurosurgery and oncology may be involved. Embolization was first reported by Dr Frieda Feldman in 1975 as a useful adjunct in the management of selective bone tumours (2). Today, arterial embolization prior to surgical resection has been employed as neoadjuvant therapy of such tumours (1, 3-12). In our series, pre-operative embolization was performed successfully in 92% of the patients, which is comparable to other investigators. Although the definition of technical success differs, successful catheterization of the tumour-supplying arteries and obliteration of >70% of the tumour staining are well accepted as the definition of technical success (5, 13-16)

Results from some investigators have shown that successful embolization can decrease intraoperative blood loss to approximately 500 mL (13, 17). In a large series of 51 patients, Barton et al (14) reported intraoperative blood loss of 500-1,500 mL in patients who had undergone pre-operative embolisation; patients who had not undergone any embolotherapy had an intra-operative blood loss of 2,000-18,500 mL. In a study by Wirbel et al (18), it reported a mean intra-operative blood loss of 1,650 mL for spinal lesions and 2,250 mL for peripheral pelvic lesions after the patients had undergone embolotherapy. Similarly, Manke et al (19) reported significantly reduced intraoperative hemorrhage in patients with spinal metastases from renal cancer that underwent pre-operative embolization with PVA particles (1500mL for complete and 2200mL for partial embolizations) compared to patients treated surgically without pre-operative embolization (5000mL). Likewise, Kickuth et al (11) reported a median intra-operative blood loss of 600mL with a range of 200 - 4,000mL for patients who have had good devascularization of tumour. In our study, we found our intra-operative blood loss to range from negligible to 1,500mL with a mean of 427mL and a median of 300mL, which is considerably lower than previous studies mentioned. However comparison is very difficult between different studies as the tumour (type and location) and surgical procedures are very heterogeneous.

Complications of embolization are wide and varied and they include dissection of feeding arteries, pain from ischemic necrosis of the tumor, accidental embolization of non-tumour vessels, infection, and post-embolization syndrome (9, 11, 13, 14, 20). In our series, we experienced a dissection of a tumour-feeding artery arising from the anterior branch of internal iliac artery. The overall complication rate in our series was 7% comparable to other investigators (11)

There are several limitations to our study. Firstly, data collection was retrospective, and comparison with a non-embolization group was not available. However, by cross-referencing with multiple studies from the literature, we hope to provide a fair depiction of trans-arterial embolization as an adjunct to orthopaedic tumour surgery. Secondly,
our study population was not homogeneous with respect to tumour types and the type of surgery performed. However, this also reflects the clinical setting of primary and metastatic tumours both referred simultaneously to the interventional radiologists for pre-operative embolization.

Images for this section:
Fig. 1: Case 1. Radiograph of left hip AP view. The arrow points to lytic lesion in proximal femur. A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.
Fig. 2: Case 1. T2 Weighted axial image demonstrating hyperintense lobular lesion in the femoral cortex, extending to adjacent soft tissues (arrow). A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.
Fig. 3: Case 1. The lesion is isointense in this T1 weighted axial image. A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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Fig. 4: Case 1. Intense contrast uptake with extension to adjacent soft tissues noted in this post contrast T1 sagittal image (arrow). A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.
Fig. 5: Case 1. The angiogram from common femoral artery demonstrate tumor neovascularity (arrow). A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation $>70\%$) achieved in this case following embolization.

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Fig. 6: Case 1. The post embolization angiogram demonstrates marked devascularization of tumor (arrow). A 52 year old female presented with metastatic lesion in proximal femur from follicular cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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Fig. 7: Case 2. Pelvic radiograph demonstrating no obvious lytic lesion. A 39 year old male presented with large mass in left groin. The histopathology was shown to be spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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**Fig. 8:** Case 2. T1 axial image demonstrating isointense soft tissue tumor arising from left ilio-psoas (arrow). A 39 year old male presented with large mass in left groin. The histopathology was shown to be spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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Fig. 9: Case 2. T2 coronal image demonstrating multiple septation and cystic/necrotic area within (arrow). A 39 year old male presented with large mass in left groin. The histopathology was shown to be spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.
Fig. 10: Case 2. Post contrast T1 sagittal image confirm cystic/necrotic areas with enhancing solid component within the tumour. A 39 year old male presented with large mass in left groin. The histopathology was shown to be spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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Fig. 11: Case 2. The angiogram demonstrates tumour vascularity (arrow). A 39 year old male presented with large mass in left groin. The histopathology was shown to be
spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

Fig. 12: Case 2. Post embolization angiogram demonstrating marked decrease in tumor vascularity (arrow). A 39 year old male presented with large mass in left groin. The histopathology was shown to be spindle cell carcinoma. Technical success (devascularisation >70%) achieved in this case following embolization.

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Fig. 13: Case 4. Pelvic radiograph demonstrating large lytic lesion in left iliac bone (arrow). A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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Fig. 14: Case 4. T1 weighted axial image demonstrating isointense tumour in left iliac bone. A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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Fig. 15: Case 4. On T2 TIRM coronal image, the tumour is mildly hyperintense with few cystic spaces within (arrow). A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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Fig. 16: Case 4. Post contrast T1 coronal image demonstrating enhancing predominantly solid tumor in left iliac bone. A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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Fig. 17: Case 4. The pre-embolization angiogram demonstrating tumor neovascularity (arrow). A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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**Fig. 18:** Case 4. Post embolization angiogram demonstrates marked tumour devascularisation (arrow). A 20 year old presented with rapidly expanding osteosarcoma involving the left iliac bone.

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<table>
<thead>
<tr>
<th>Case No</th>
<th>Interval to surgery (days)</th>
<th>Surgery</th>
<th>Blood loss as per record (ml)</th>
<th>Intra-operative blood transfusion</th>
<th>Post-operative blood transfusion</th>
<th>Pre-operative haemoglobin gm/dl</th>
<th>Post-operative haemoglobin gm/dl</th>
<th>HB drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Wide resection</td>
<td>1500</td>
<td>PRBC* 300 ml</td>
<td>PRBC 1200 ml</td>
<td>12.5</td>
<td>7.3</td>
<td>-5.2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Wide resection</td>
<td>250</td>
<td>PRBC 300 ml, FFP 500 ml</td>
<td>Nil</td>
<td>10.8</td>
<td>9.7</td>
<td>-1.1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>Hemipelvectomy</td>
<td>FFP** 55ml</td>
<td>PRBC 600 ml</td>
<td></td>
<td>11.9</td>
<td>7.9</td>
<td>-4</td>
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<tr>
<td>4</td>
<td>4</td>
<td>Hemipelvectomy</td>
<td>PRBC 470 ml</td>
<td>PRBC 600 ml</td>
<td></td>
<td>14.1</td>
<td>9.7</td>
<td>-4.2</td>
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<tr>
<td>5</td>
<td>3</td>
<td>Wide resection</td>
<td>380</td>
<td></td>
<td>Nil</td>
<td>15</td>
<td>12</td>
<td>-3</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>Resection and femur plating</td>
<td>300</td>
<td>PRBC-304 ml</td>
<td>Nil</td>
<td>9.1</td>
<td>10.2</td>
<td>+1.1</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>T8,9 laminectomy, spinal decompression and tumour biopsy</td>
<td>500</td>
<td></td>
<td>PRBC 300 ml</td>
<td>12.6</td>
<td>10.2</td>
<td>-2.4</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>Abdominoperineal resection and en-bloc excision of sacral chordoma</td>
<td>-</td>
<td>-</td>
<td>PRBC 300 ml</td>
<td>10</td>
<td>15.3</td>
<td>+5.3</td>
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<tr>
<td>9</td>
<td>6</td>
<td>Hartmann’s procedure and excision of tumour</td>
<td>500</td>
<td></td>
<td>PRBC 900 ml</td>
<td>12.3</td>
<td>9.9</td>
<td>-2.4</td>
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<tr>
<td>10</td>
<td>7</td>
<td>Curettage of bone tumour</td>
<td>250</td>
<td>PRBC 568 ml</td>
<td>Nil</td>
<td>12.1</td>
<td>12.5</td>
<td>+0.4</td>
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</table>
Fig. 19: Table 3: Surgery and transfusion details. *PRBC- Packed Red Blood Cells; ** FFP- Fresh Frozen Plasma

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Conclusion

Trans-arterial embolization of musculoskeletal tumours prior to the surgery is a safe procedure with high technical success with a potential to reduce blood loss during surgery.

Personal information

References


