Transcatheter Arterial Embolization for Musculoskeletal Pain

Taku Yasumoto, MD., PhD.
Department of Interventional Radiology, Miyakojima IGRT Clinic, Osaka, Japan

Introduction

Approximately 10-22% of people are suffered from chronic pain, most of which involves the musculoskeletal (MSK) system. Chronic MSK pain is caused by various inflammatory, degenerative diseases including adhesive capsulitis, osteoarthritis (OA), tendinopathy and enthesopathy.

Those patients have been treated by surgical or non-surgical treatment such as anti-inflammatory drugs. However, up to 50% of patients showed persistent symptoms despite of non-surgical treatment. Furthermore, the efficacy of some of nonsurgical treatments has not been clearly confirmed with evidence. Although some evidence supports the notion that surgical intervention could benefit these conditions, the results have been disappointing, with failure rates of 20-30%.

Therefore, both of non-operative conservative measures including physical therapy, anti-inflammatory medications, corticosteroid injections and surgical treatments are not considered to be satisfactory.

Angiogenesis in chronic musculoskeletal (MSK) pain and Embolization

Recently, angiogenesis is believed to contribute to the genesis of inflammation particularly to its maintenance. The new increased vascular network provides inflammatory cells to the synovium and other joint tissue, and it may promote additional hyperplasia and inflammation leading to bone and cartilage destruction. In addition, studies on OA have shown that angiogenesis may contribute to chronic pain by enabling the growth of new unmyelinated sensory nerves along their path.

Okuno et al. investigated the effects of transcatheter arterial embolization (TAE) of abnormal blood vessels about the chronic MSK pain refractory to nonsurgical management. TAE for chronic pain has been gradually spread as a treatment option alternative to conservative or surgical treatment.

Transarterial embolization -Basic techniques and Devices-

Treatment options of MSK chronic pain include conservative management (including rest, physical therapy, stretching, muscle strengthening, medication of pain relievers such as acetaminophen or nonsteroidal anti-inflammatory drugs, oral opioid agents, intraarticular injection of corticosteroid or hyaluronic acid), surgical treatments, and TAE.

Indication

General indication for TAE includes chronic joint pain due to OA, synovitis,
overusing, or sports injury resistant to 3 months or more of conservative therapies and persistent pain (visual analog scale [VAS] score > 50). On the other hand, exclusion criteria are local infection, malignancy, advanced atherosclerosis, rheumatoid arthritis, severe mental disorders, severe bone deformation around the joint on radiographs, uncontrollable diabetes, and surgery indication.

**Techniques**

Arterial access sites are depended upon the location of diseases. Radial or brachial approaches are commonly used for the lesions involving upper limbs, and femoral approach was preferably used for lower limbs lesions. Catheter insertion is performed with 3- or 4-F introducer sheath under local anesthesia. When lower limb, the femoral artery (FA) is punctured in an ipsilateral antegrade fashion under ultrasound guidance. Selective angiography usually reveals abnormal vessels as tumor blush-type enhancement in the arterial phase, often accompanied by early venous drainage. After the abnormal vessels are identified, embolic material; 0.5 g Imipenem/cilastatine sodium (IPM/CS) in 5-10 mL iodinated contrast agent is infused slowly until blood flow stagnated on angiography (Figure 1). IPM/CS forms particles (approximately 50-130μm) have exert as embolic material. If needed, 1.7 - 2.4-F microcatheter is inserted coaxially and selectively placed in the targeted arteries. The patients are discharged on the same day they are treated.

**Adhesive capsulitis / Frozen Shoulder**

Patients with adhesive capsulitis with nighttime shoulder pain or painful restriction of motion are good indications for TAE. Suprascapular artery originated from the subclavian artery (SCA), thoracoacromial artery, corachoid branch, circumflex scapular artery, anterior circumflex humeral artery, and posterior circumflex humeral artery branched from SCA originated from the axillary artery are the target vessels. There are dangerous arteries of ascending cervical artery and deep cervical artery. They have anastomoses to radiculomedullary artery, spinal artery, or vertebral artery. Before and after TAE, numerical rating scale (NRS) at rest, on motion, and at nighttime and range of motion (ROM) should be assessed for effect of TAE. Okuno et al reported 67% of the patients experienced quick improvement of nighttime pain within 1 week, and 87% experienced improvement within 1 month and that at 1 year after TAE, 88% of patients were completely pain-free. The results of phase-II multicenter trial of MSK embolization for shoulder pain in Japan (UMIN 000021238) are now under submission. There had been total of 100 cases entries for this trial and 80% of them could be followed 6 months after TAE. There were no major procedure-related complications. In this study, 81% patients got initial improvement of nighttime pain score within 1 week. NRS score of nighttime pain was statistically significant improved from 6.4 to 1.8 after 6 months follow-up (P<.001). Mean ROM of forward elevation and external rotation was also improved after TAE.
Knee OA

Patients with knee pain due to mild to moderate knee OA changes (Kellgren-Lawrence grade 2 or lower) are also good indications for TAE. In addition to VAS score, Western Ontario and McMaster University Osteoarthritis Index (WOMAC) questionnaire, which includes 24 questions on daily activities is performed before and after the procedure. After catheter insertion from FA, descending genicula artery (DGA) should be selected and embolized at first on digital subtraction angiography (Figure 2). In almost patients with chronic knee pain, DGA embolization is necessary. However, selective angiography shows that other branches of genicular arteries originated from popliteal artery sometimes make anastomosis each other. Therefore, gentle injection of embolic agent is important for avoiding non-target embolization. TAE rapidly improves WOMAC pain scores from 12.2 to 3.3 at 1 month after the procedure and WOMAC total scores from 47.3 to 11.6 at 1 month, and to 6.3 at 4 months. A second TAE procedure should be considered if pain persisted or relapsed within 6 months of the initial procedure. Embolic material used is commonly IPM/CS as mentioned above, but successful genicular artery embolization (GAE) using 75 or 100μm Embozene Microspheres (Boston Scientific, Mariborough, MA) was reported without severe complication. The presented GAE significantly improved pain as measured by VAS and WOMAC (baseline VAS 76 mm, mean decrease -47 mm, p<0.01; baseline WOMAC 61, mean decrease 32, p<0.01). The optimal embolic material should be researched in the near futures.

Future Perspectives

Although TAE is a new useful interventional procedure for chronic MSK pain, the indication or effect of the treatment is not well quantitatively established, and pain score is subjective evaluation. As a pre-treatment imaging, X-ray examination is often performed, but there are almost no severe abnormalities and there is no suitable guideline on pain images at present. Comparison the contrast enhanced magnetic resonance imaging (MRI) before and after TAE for the evaluation of contrast effect around the joint and the correlation with therapeutic effect was reported (Figure 3). In the present study, a significant reduction of contrast enhancement on MRI was observed in patients with good therapeutic effect for chronic MSK pain treated with TAE (Table). The indication or effect of the treatment, and details of TAE technique including the optimal embolic material should be validated in the future.

Conclusion

TAE is a potential treatment option in patients with chronic MSK pain resistant to conservative treatment. Scientifically, further investigation is warranted, particularly with prospective studies in comparison with a control group to confirm the effects of TAE.
Figure 1: A characteristic case of TAE for adhesive capsulitis
57-year-old male with chronic shoulder pain treated with TAE using IPM/CS.
A) Right subclavian arteriography reveals many branches.
B) Selective angiography of the anterior humeral circumflex artery before embolization shows abnormal vessels (black arrows) and early venous drainage (white arrowheads) at a early time point.
C) After embolization, the contrast medium distributes more slowly, and the abnormal vessels and the drainage vein are not evident at the same time point.

Figure 2: Relevant arterial anatomy for TAE of knee chronic pain
Descending genicular artery (DGA) should be selected and embolized at first on digital subtraction angiography. In almost patients with chronic knee pain, DGA embolization is necessary.
Figure 3: Contrast-enhanced MRI before and after TAE for chronic pain in the right knee (T1-weighted fat suppression image (3D image))

The contrast effect of the synovium on the right knee (abnormal blood vessels) (A) (white arrow) disappeared completely after treatment (B), and pain improved significantly (NRS: 10 → 0).

<table>
<thead>
<tr>
<th>Group</th>
<th>N (lesions)</th>
<th>NRS pre-TAE</th>
<th>NRS post-TAE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: invariant</td>
<td>37 (17.7%)</td>
<td>8.1</td>
<td>5.9</td>
<td>0.571</td>
</tr>
<tr>
<td>B: mild</td>
<td>74 (34.4%)</td>
<td>8.3</td>
<td>4.3</td>
<td>0.241</td>
</tr>
<tr>
<td>C: marked</td>
<td>104 (48.2%)</td>
<td>9.2</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>215</td>
<td>8.5 (average)</td>
<td>4.3 (average)</td>
<td></td>
</tr>
</tbody>
</table>

Table: Contrast reduction of enhancement on MRI after TAE was classified into three groups: A: invariant, B: mild, and C: marked

The NRS value decreased significantly in group C compared with group A (P<0.05). A significant reduction of contrast enhancement on MRI was observed in patients with good therapeutic effect for chronic MSK pain treated with TAE.

Special thanks to Dr. Yuji Okuno (Okuno Clinic.), Dr. Masamichi Koganemaru (Kurume University), Dr. Hiro Kiyosue (Oita University), and Prof. Koichiro Yamakado (Hyogo College of Medicine) for providing important resources for this lecture.
References


33. Transcatheter Arterial Embolization for Musculoskeletal Pain (Taku Yasumoto, MD, PhD)

33. Transcatheter Arterial Embolization for Musculoskeletal Pain (Taku Yasumoto, MD, PhD)


