CLINICAL STUDY

Clinical Outcomes of Transcatheter Arterial Embolization for Adhesive Capsulitis Resistant to Conservative Treatment

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ABSTRACT

Purpose: To evaluate clinical outcomes of transcatheter arterial embolization (TAE) for adhesive capsulitis resistant to conservative treatments.

Materials and Methods: This study comprised 25 patients (18 women and 7 men; mean age, 53.8 y; range, 39–68 y) with adhesive capsulitis resistant to conservative treatments. TAE was performed, and adverse events (AEs), pain visual analog scale (VAS) score changes, range of motion (ROM), and American Shoulder and Elbow Surgeons (ASES) scores were assessed.

Results: Abnormal vessels were identified in all patients. No major AEs were associated with TAE. One patient was lost to follow-up. The remaining 24 patients were available for final follow-up (mean, 36.1 months; range, 30–44 months). Of the 24 patients, 16 (67%) experienced quick improvement of nighttime pain (ie, VAS scores decreased $>$ 50% from baseline) within 1 week, and 21 (87%) improved within 1 month. In terms of mean overall pain (ie, pain at its worst), VAS scores significantly decreased at 1, 3, and 6 months after treatment (82 mm before treatment vs 52, 19, and 8 mm after treatment; $P < .001$). ASES scores significantly improved at 1, 3, and 6 months after treatment (16.1 before treatment vs 41.4, 69.1, and 83.5 after treatment; $P < .001$). No symptom recurrence or late-onset AEs were observed. Shoulder ROM and function further improved during midterm follow-up.

Conclusions: TAE is a possible treatment option for patients with adhesive capsulitis that has failed to improve with conservative treatments.

ABBREVIATIONS

AE = adverse event, ASES = American Shoulder and Elbow Surgeons, IPM/CS = imipenem/cilastatin sodium, ROM = range of motion, TAE = transcatheter arterial embolization, VAS = visual analog scale

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Figures E1, E2, and Videos 1–3 are available online at *www.jvir.org*.

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Adhesive capsulitis, also referred to as frozen shoulder, is a common but poorly understood condition that is characterized by a gradual onset of shoulder pain and restriction of shoulder motion (1). This chronic fibrosing condition has long been considered to be a self-limiting condition (over a period of 18–24 months) that renders invasive treatment modalities superfluous (2). However, more recent literature has reported less optimistic outcomes, with a protracted course and an incomplete recovery (1,3,4). Although conservative measures (eg, physical therapy, antiinflammatory medication, corticosteroid injections) are first-line treatments, it has been reported that 30% of patients do not improve with these measures (3). After failure of conservative treatment, further invasive treatment (ie, manipulation under anesthesia and surgical procedures) has been performed. However,

there has been no consensus regarding invasive treatment options for refractory cases.

Based on the idea that an increased number of blood vessels and accompanying nerves are a possible source of inflammation and pain, we have used transcatheter arterial embolization (TAE) of abnormal vessels in patients with resistant adhesive capsulitis and have previously reported positive results, without any complications (5). However, the safety profile and midterm outcomes could not be meaningfully determined in our previous study because of the small number of patients with short follow-up periods. The purpose of the present study was to examine the short-term clinical success rate in a greater number of cases than the previous study and the midterm safety profile and clinical outcomes of TAE for resistant adhesive capsulitis.

MATERIALS AND METHODS

This prospective study was approved by the institutional review board. Between April 2012 and July 2013, 177 patients with shoulder pain and stiffness attended the shoulder clinic; 94 patients were diagnosed with adhesive capsulitis, according to the following criteria (3,6–8): nighttime shoulder pain, painful restriction of both active and passive forward elevation $< 100^{\circ}$ and external rotation to $< 50\%$ on the contralateral side, normal plane radiographic appearance, and no secondary causes. All patients were assessed using ultrasound, and patients with full-thickness rotator cuff tears were excluded. With ≥ 3 months of conservative treatment, which included rest, antiinflammatory drugs, corticosteroid injections, and physical therapy, 32 patients reported partial improvement, and 28 were lost to follow-up. The remaining 34 patients who reported no meaningful improvement were considered to have treatment-refractory adhesive capsulitis. Of these patients, 31 still had persistent moderate to severe pain, as assessed by a visual analog scale (VAS) score > 50 mm (the degree of pain was rated on a 100-mm scale, with the absence of pain rated as 0 and severe pain rated as 100) (9). These patients were eligible for the study, and they all received an explanation about other invasive options and the potential risks, benefits, and outcomes of TAE. Written informed consent was obtained from 25 patients, including the 7 patients enrolled in our previous study (5). Patient demographic data are summarized in Table 1. Of the remaining 6 patients who did not agree to participate in the present study, 5 received manipulation procedures (involving stretching the shoulder capsule by forcefully moving the humerus in several directions under anesthesia), and 1 patient continued to receive conservative treatments.

Procedure Details

All cases were performed by 2 interventional radiologists with 6 years (Y.O.) and 12 years (T.Y.) of experience.

Table 1. Baseline Patient Data (n = 25)

Variable	Value
Age, y	53.8 (39–68)
Pain duration, months	7.7 (3–24)
Sex, male/female	9/16
Affected side, right/left	16/9
Diabetes mellitus	6 (24%)
Baseline evaluation	
Overall pain VAS, mm	82 (65–100)
Nighttime pain VAS, mm	68 (50—100)
Forward elevation ROM, °	77 (60–95)
External rotation ROM, °	8 (0–25)
ASES score	16.1 (8.3–23.3)
Prior conservative treatments	
Physical therapy	21
Duration, months	3.8 (3–8)
Oral NSAIDs	20
Duration, months	4.5 (3–10)
Corticosteroid injection	18
Number of injections	2.9 (1–6)

Note–Values are presented as or mean (range) or number. ASES = American Shoulder and Elbow Surgeons; NSAIDs = nonsteroidal antiinflammatory drugs; ROM = range of motion; VAS = visual analog scale.

Under local anesthesia, percutaneous arterial access was gained using a 3-F introducer sheath (Super Sheath; Medikit Co, Ltd, Tokyo, Japan) from the ipsilateral radial artery (n = 20) or the femoral artery (n = 4). In all cases, after intravenous administration of 2,000 IU of heparin, a 3-F angiographic catheter was inserted (Multipurpose; Medikit Co, Ltd). Digital subtraction angiography from the subclavian and axillary arteries was performed with manual injection of 3–5 mL of contrast medium to locate the arteries feeding the shoulder joint (Fig 1a). The suprascapular artery originates from the subclavian artery, and the remaining 4 arteries and 1 branch originate from the axillary artery. Selective angiography from the arteries shown in Figure 1a was performed through manual injection of 3 mL of contrast medium at an injection rate of 1 mL/s with the 3-F angiographic catheter located at the origin of each artery. Abnormal vessels were characterized as "tumor blush"–type enhancement, which appeared at arterial phase, often accompanying early venous filling. These findings are concordant with previous descriptions of abnormal hypervascularity of joint tissue (10–12).

After identifying the abnormal vessels, imipenem/cilastatin sodium (IPM/CS) (Primaxin; Merck & Co, Inc, Whitehouse Station, New Jersey) was infused as the embolic agent, based on our previous report (5). These compounds are slightly soluble in water, and when suspended with a contrast agent, they form crystalline particles that exert transient or temporary embolic effects (13). A suspension of 0.5 g of IPM/CS in 5–10 mL of contrast agent was prepared by pumping syringes for