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Shoe rim and shoe buckle pseudotumor of the ankle in elite and professional figure skaters and snowboarders: MR imaging findings

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Abstract *Objective:* To review MR imaging of figure skaters and snowboarders presenting with painful soft-tissue swelling of the lateral supramalleolar region with a clinical provisional diagnosis of soft-tissue tumor. *Design and patients:* MR imaging was prospectively reviewed by two sub-specialized musculoskeletal radiologists. The findings were correlated with a second clinical review and examination of the shoe wear. The patients were four female athletes undergoing heavy training regimes, ranging in age between 16 and 25 years. Two patients were elite figure skaters, and two were professional snowboarders. Three patients had unilateral masses with pain, and one patient presented with bilateral clinical findings. *Results:* MR imaging showed subcutaneous, focal soft-tissue masses of the supramalleolar region in five ankles at the same level above the ankle joint. MR imaging prompted a second clinical review and correlation with the shoe wear. The MR imaging findings correlated to the level of the shoe rim or shoe buckle in all patients, confirming the suspected MR imaging diagnosis of an impingement syndrome. All four sportswomen were training excessively, ignoring safety advice regarding training duration, timing of breaks, and shoe wear rotation. *Conclusion:* Ice skaters and snowboarders may present with persistent and disabling pain. On MR imaging, this corresponds to a focal soft-tissue abnormality, which may be due to subcutaneous fat impingement between the fibula and the shoe rim or shoe buckle.

Keywords MR imaging, ankle · MR imaging soft tissue, pseudotumor · MR imaging elite figure skaters · MR imaging professional snowboarders · Pseudotumor of the ankle

Introduction

Elite figure skaters and professional snowboarders are often young athletes involved in highly competitive and extremely stressful training with the risk of serious ankle injuries and overuse syndromes [1, 2, 3]. Overuse syndromes of the ankle joint region have been described, including tendonitis and malleolar bursitis [1, 2]. However, to our knowledge, there have not been any MR imaging or clinical descriptions of subcutaneous impingement of the ankle region by the shoe rim or shoe buckle with formation of a pseudotumor in elite figure skaters or professional snowboarders. We describe the MR imaging and clinical findings of this entity in four sportswomen.

Patients and methods

Four female patients, two elite figure skaters and two professional snowboarders (age range 16–25 years, mean 18.5 years), presented with exquisite supramalleolar pain and a clinically focal soft-tissue mass of at least 2 months' duration. These four patients were referred for MR imaging by sports medicine and orthopedic surgeons for review of this region with a clinical provisional diagnosis of a

soft-tissue tumor. Three patients had unilateral clinical findings, and one patient had bilateral abnormalities. In the elite figure skaters, the ankle involved was the leading take-off foot for jumping and landing, and in the snowboarders the right front foot on the board was involved. Initially, after presenting to sports medicine clinicians, ceasing training for a period of time relieved the pain. However with return to heavy training and stress of pre-competition, the pain re-emerged and continued during training and normal daily activities, and focal soft-tissue masses developed. Prolonged training schedules with jumping and excessive curve practice made the symptoms worse. The sportswomen were not involved in cross-training. At an initial clinical review of all four patients and five ankles, there was a focal, exquisitely tender mass in the supramalleolar region. In the two snowboarders, there was additional pain of a more diffuse and deeper nature over a larger region encompassing the distal two-thirds of the lower limb.

MR imaging with intravenous contrast administration was performed on five ankles. At our institution, contrast is routinely given for MR tumor imaging. The imaging was reviewed by two musculoskeletal radiologists by consensus. The MR imaging protocol included demarcation of the level of the painful mass with a vitamin capsule, coronal STIR (short tau inversion recovery) (TR: 5720–3340, TE: 14), axial T1-weighting (TR: 751–519, TE: 15–13), T2-weighting (TR: 3400–2800, TE: 102–85), axial STIR (T1: 180, TR: 5780–3120, TE: 15), and fat-saturated, postcontrast enhanced T1-weighting in the coronal (TR: 519, TE: 15) and axial (TR: 420, TE: 15) planes. The field of view was 24, slice thickness 4 mm with 1 mm gap, and matrix of 512 for all sequences. A dedicated extremity coil was used, with the patient lying in the supine position. Anteroposterior and lateral radiographs were reviewed for bone destruction, periosteal reaction, and soft-tissue calcification. Location, size, and MR signal characteristics of the soft tissues and any underlying muscle or bone abnormalities were recorded. Following MR, the patients were re-examined by a sports medicine and a foot sub-specialized orthopedic surgeon, and the MR findings were correlated with the clinical findings and with the height of the shoe rim and the location of any shoe buckles/material fatigue regions of the shoe.

Results

All four patients had focal, subcutaneous, soft-tissue signal intensity alterations lateral to the fibula, 4–7 cm proximal to the distal tip of the fibula, correlating to the focally painful, clinically palpable soft-tissue mass (Fig. 1). One figure skater had bilateral findings (Fig. 2). These regions varied in size from 1.6 cm to 3.5 cm. In all five ankles, the exquisitely tender soft-tissue masses correlated exactly to the level of the shoe rim in the figure skaters and to the level of the buckle in the fatigued material of the lateral aspect of the shoe in the snowboarders (Fig. 3).

MR signal characteristics in four of the five ill-defined mass-like regions were isointense to muscle on T1-weighting, increased on T2-weighted and STIR imaging with intravenous contrast enhancement within the soft-tissue mass-like region in all five ankles. The remaining one was low signal intensity on T2-weighting and was associated with a longer clinical course. MR imaging also excluded the presence of a focal soft-tissue mass compatible with tumor, for which the patients had been initially referred. Clinical and MR findings are summarized in Table 1. Radiographs were normal in all patients, with an absence of bone destruction, periosteal reaction, fracture, or soft-tissue calcification, though there was diffuse cortical thickening of the distal fibula in the two professional snowboarders. Conservative treatment included a break from training and modification of excessive training schedules to more realistic ones with appropriate rest periods and rotation of shoe wear. With initially contin-

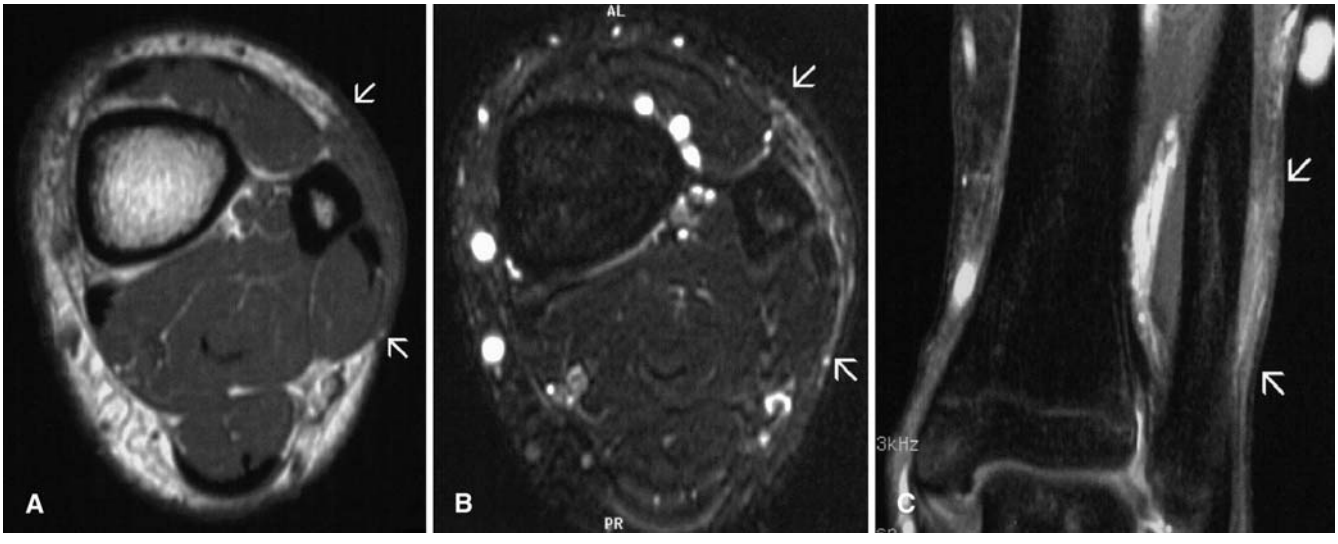

Fig. 1A–C A 16-year-old female figure skater with left-sided, painful soft-tissue mass. **A** Axial T1-weighting (TR: 519, TE: 15) shows 3.5 cmx8 mmx3.5 cm subcutaneous soft-tissue mass-like region of altered signal intensity (*arrows*) isointense to muscle signal intensity. The mass-like lesion is lateral to the fibula and approximately 5 cm proximal to the tip of the distal fibula. Prominence of the fibular cortex and peroneal musculature is noted. **B** Corresponding axial STIR (short tau inversion recovery) (TI: 180, TR:5780, TE: 15) image shows increased signal intensity within this region (*arrows*). **C** Postcontrast, coronal, enhanced, T1-weighted, fat-saturated image (TR: 519, TE: 15) shows contrast enhancement within the mass region (*arrows*)

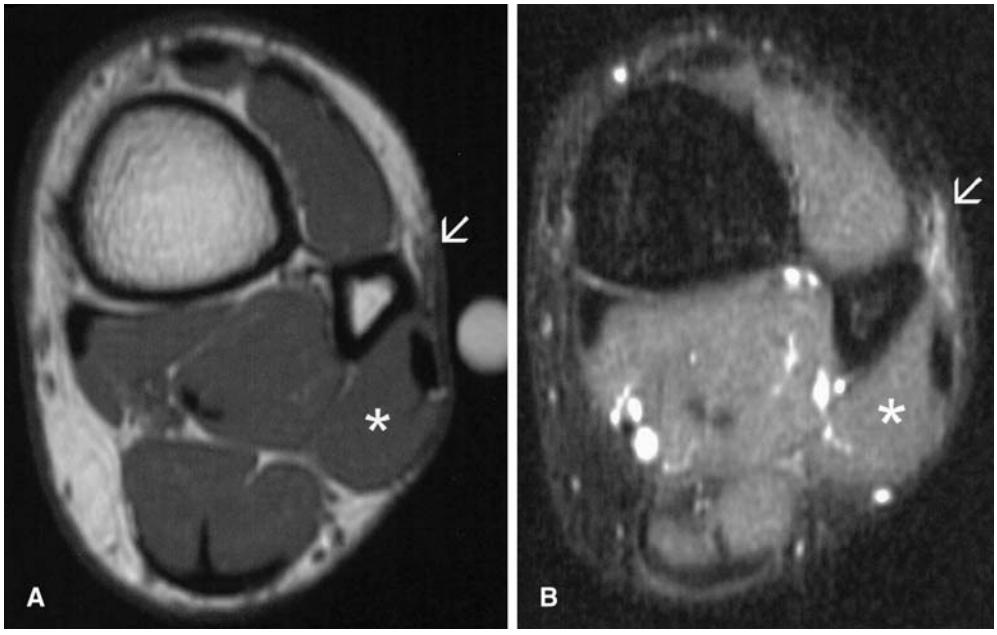

Fig. 2A,B A 16-year-old female figure skater with bilateral ankle pain and focal masses. **A** Axial T1-weighting (TR: 519, TE: 15) of the left ankle shows altered subcutaneous signal intensity (2 cmx3 mmx2.5 cm) lateral to the fibula (*arrow*), 5 cm proximal to the tip of the distal fibula. Prominent peroneal musculature is noted at this level (*). **B** Axial STIR (T1: 180, TR: 3120, TE: 18) image of the right ankle shows increased subcutaneous signal intensity (2 cmx4 mmx1.5 cm) compared with muscle lateral to the fibula (*arrow*), 5 cm proximal to the tip of the distal fibula

Table 1 Summary of clinical and MRI and other imaging findings

Patient no.	Age	Gender	Sport	Clinical provisional diagnosis	Radiograph	MR signal characteristics				MR size	Treatment
						T1	T2	STIR	Post-contrast		
1	16	Female	Ice skater	Mass or stress fracture	Normal	Isointense	Increased	Increased	Increased	3.5 cm×8 mm×3.5 cm	Conservative
2	25	Female	Snowboarder	Mass	Normal	Isointense	Decreased	Increased	Increased	1.6 cm×4 mm×1.5 cm	Conservative
3	17	Female	Snowboarder	Mass	Normal	Isointense	Increased	Increased	Increased	1.5 cm×3 mm×1.5 cm	Conservative
4 (left side)	16	Female	Ice skater	Mass ? ganglion	Normal	Isointense	Increased	Increased	Increased	2 cm×3 mm×2.5 cm	Two anesthetic and steroid injections 1 month apart
4 (right side)	16	Female	Ice skater	Mass ? ganglion	Normal	Isointense	Increased	Increased	Increased	2 cm×4 mm×1.5 cm	Two anesthetic and steroid injections 1 month apart

ued excessive training, purchase of custom-made shoe wear of a different brand did not influence the symptomatology in the one figure skater with bilateral disease. In this one patient, the MR imaging findings were used to guide steroid and local anesthetic injections into the mass (twice, 1 month apart) with symptomatic relief.

Evidence of prominent musculature was seen in all 5 ankles, particularly the peroneal muscle group.

All patients trained with marked lateral overuse with varus stress on the fibula. The skaters jumped and landed in a varus position. The snowboarders had constantly active peroneal musculature with the bow-legged skiing position and ‘wheely’ technique with presumably recurrent impact in the varus position, also suggested by the two distal fibular stress reactions in the two professional snowboarders. Distal fibular stress reactions on MR imaging were evident at a more proximal level compared with the soft-tissue abnormalities and were associated with more diffuse chronic pain in the two professional snowboarders. The pseudotumors were more exquisitely painful, more distal, closer to the ankle joint, and present lateral to the fibula. There was no evidence of lateral malleolar bursitis or an abnormal bone marrow signal. At follow-up, after reduced activity over 3 months, there was a decrease in size of the soft-tissue abnormality and reduction in pain.

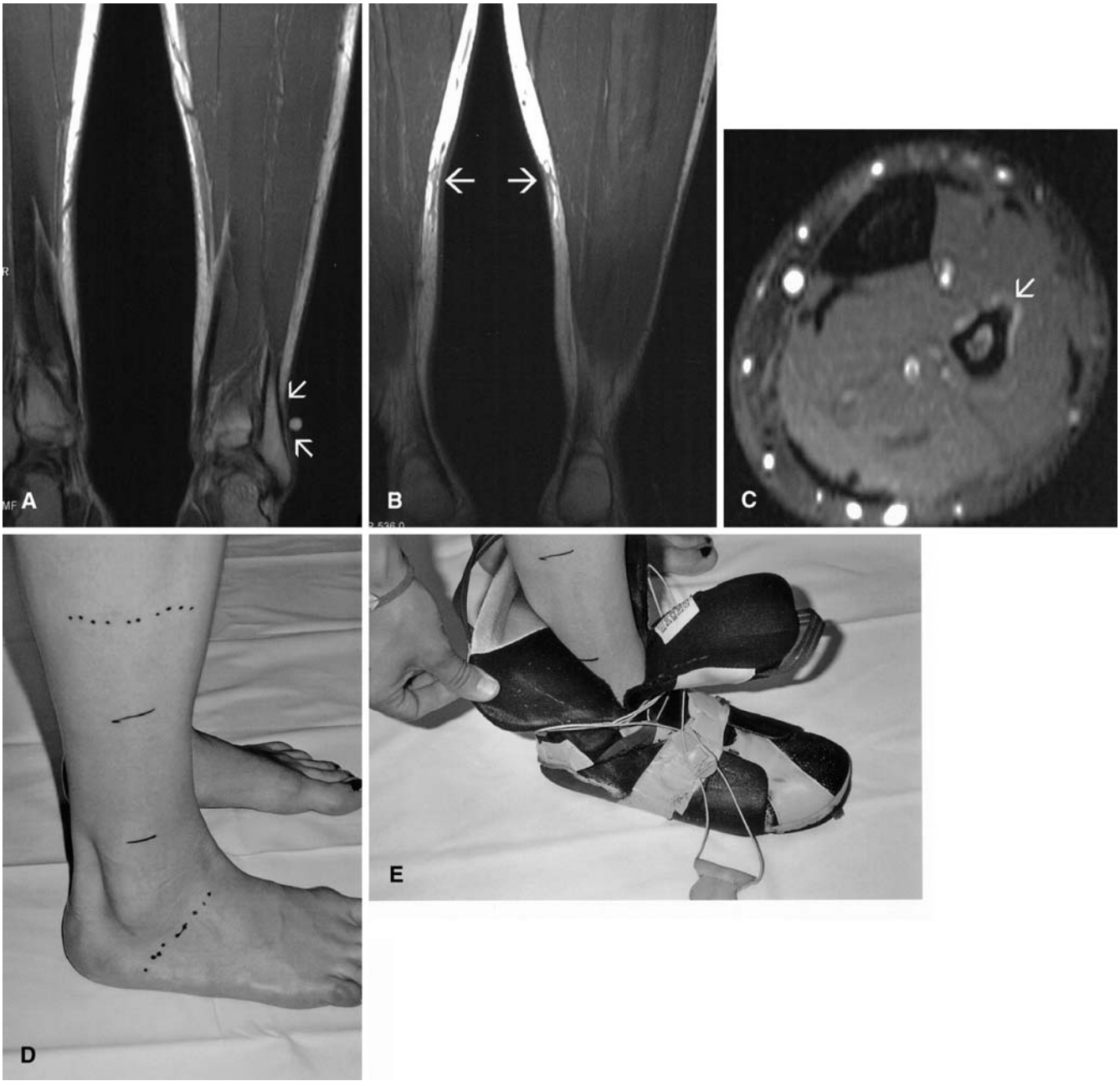

Fig. 3A–E A 25-year-old professional female snowboarder with a 12-week history of a focal pain in the lateral malleolar region. She had a minimum of 8-h training sessions daily for a continuous period of 3 months. The other 17-year-old female professional snowboarder had the same clinical history, training scheme, and MR imaging findings. **A** Coronal T1-weighting (TR: 536, TE: 13) with a vitamin capsule demarcating the maximal region of pain and the location of the soft-tissue mass-like region (*arrows*). **B** More posterior, coronal T1-weighting shows altered subcutaneous signal intensity (*arrows*) corresponding to the medial aspect of the soft boots' upper margin. These regions were asymptomatic. **C** Axial, postcontrast, enhanced, fat-saturated T1-weighting (TR: 632, TE: 14) shows a fibular stress reaction within the bone marrow of the distal fibular with periosteal reaction (*arrow*). Radiographs were normal. **D** Clinical image shows the area of pain and soft-tissue swelling between the two *solid lines*. **E** Clinical image of the custom-made inner shoe demonstrates the level of the buckle within the fatigued material, which corresponds to the level of the soft-tissue abnormality

Discussion

A large variety of injuries have been described in figure skaters and snowboarders, and as competition increases and training intensifies [3], the incidence of injuries in these athletes may be increasing [1]. To our knowledge, however, there have been no MR imaging or clinical descriptions of shoe rim or shoe buckle pseudotumors of the ankle region. In 1989, Smith and Ludington [1] reported overuse injuries in the ankle regions in elite pair skaters and ice dancers which included tendonitis of the peroneal, anterior tibialis, and achilles tendons, and malleolar bursitis. Several of these injuries were directly attributed to the design of the skating boot. At least half of competitive skating injuries appear to be preventable. It is recommended for young skaters that the boots should be as flexible as the skater can control and should be carefully fitted [4]. In 1992, Kjaer reported an injury incidence during competitive skating of 1.4 injuries per 1000 h of training, with 56% being acute and 44% being chronic in nature.

MR imaging played a central role in the diagnosis of the pseudotumor, supramalleolar impingement in our four sportswomen and influenced the management and training schedules. Prior to MR imaging, the diagnosis of a shoe rim or shoe buckle impingement had not been entertained clinically. All patients had been referred for MR imaging for soft-tissue tumors. In our four patients, with re-examination of the patients and close correlation of the clinical findings and shoe wear with the MR imaging findings, the diagnosis was possible. The presumed etiology of the soft-tissue abnormality and pseudotumor formation is that of subcutaneous fat compression and impingement between the shoe rim or shoe buckle, the lateral aspect of the fibula, and the prominent peroneal musculature. This is supported by the fact that all four patients had trained excessively prior to MR imaging, ignoring recommendations concerning training duration, rest periods, and rotation of shoe wear, and by the fact that the painful mass regions and symptoms improved with a rest period and appropriate training schedules. It is advised that MR imaging be performed with a vitamin capsule demarcating the site of the mass and focal pain as the region of concern, though often exquisitely painful, may be small in size and initially seemingly irrelevant. MR imaging also excluded soft-tissue and bone tumors. With chronic repetitive injury, there is presumably focal fat necrosis with a local inflammatory reaction and mass-like formation. If activity persists, eventually either fibrosis or possibly malleolar bursitis may develop. Since the subcutaneous, altered signal intensity regions corresponded exactly to the level of the shoe rim or shoe buckle and that compression or impingement of fat with necrosis or fibrosis due to overuse and poor training technique was the presumed cause and self-limited, all patients declined biopsy for histology. In our series, there was no evidence of malleolar bursitis, which has been described in elite pair skaters and ice dancers [1] and was also associated with a poor training technique.

Treatment should be aimed at prevention with optimal training regimes and specially fitted boots. It is difficult to keep a professional sportsman or sportswoman from continuing their sport.

Therapeutically, in our patients, activity restriction for 6–8 weeks was helpful. Appropriate modification of the shoewear and the training technique were discussed with the patients with moderate success. In one patient, two local anesthetic with steroid injections over a 1-month period were useful in treating the acute pain with the MR imaging guiding their placement. This was done for the patient depicted in Fig. 2. The two professional snowboarders were able to return to the same professional grade of sport prior to pseudotumor formation. The two elite figure skaters continued to have some intermittent symptoms with an increase in pre-competition training but at a level that did not affect their performance.

In conclusion, elite and professional ice skaters and snowboarders may present with persistent and disabling ankle pain associated with a soft-tissue mass. On MR imaging, this region of altered subcutaneous signal intensity may be due to subcutaneous fat impingement between the fibula and the shoe rim or shoe buckle.

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References

1. Smith AD, Ludington R. Injuries in elite pair skaters and ice dancers. Am J Sports Med 1989; 17:482–488.
2. Young CC, Niedfeldt MW. Snowboarding Injuries. Am Family Phys 1999; 59:131–136.
3. Lipetz J, Kruse RJ. Injuries and special concerns of female figure skaters. Clin Sports Med 2000; 19:369–380.
4. Smith AD. The young skater. Clin Sports Med 2000; 19:741–755.