

## Tc-99m MDP bone scintigraphy in the evaluation of the joint damage in asymptomatic alpine ski racers

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Received: 28.01.2013 • Accepted: 21.06.2013 • Published Online: 15.01.2014 • Printed: 14.02.2014

**Aim:** To evaluate the role of 99m-technetium methylene diphosphonate (Tc-99m MDP) bone scintigraphy on the detection of joint damage in asymptomatic alpine ski racers.

**Materials and methods:** This study included 20 male asymptomatic alpine ski racers (age range: 18–21 years). None of the skiers had a history of ski crashes. Bone scan findings of the racers were examined with Tc-99m MDP bone scintigraphy during the active racing season and the inactive training season. Planar anterior and posterior images of hip, knee, and ankle joints were obtained 4 h after intravenous injection of 20 mCi Tc-99m MDP. All images were interpreted visually by 2 experienced nuclear medicine physicians. Free regions of interest were drawn on hip, knee, and ankle joints, as well as background regions. Joint-to-background ratios were calculated for each joint, and the uptake ratios of both right and left joints during active ski season were compared to those during the inactive training period.

**Results:** Uptake ratios of the right and left hip, knee, and ankle joints were significantly higher during the active racing period than those calculated during the inactive period ( $P < 0.005$ ).

**Conclusion:** Bone scintigraphy may have an important role in detecting joint injuries of hip, knee, and ankle joints in asymptomatic alpine ski racers and can be used successfully when MRI is unavailable.

**Key words:** Alpine skiing, joint injuries, bone scintigraphy

### 1. Introduction

Alpine skiing is a popular sport with a significant risk of injury. Injury patterns have changed over time as ski, boot, binding, and slope-grooming technologies have evolved (1,2). Both the rate and severity of ankle and foot injuries have decreased over the time because of new ski boots and binding technologies (3–5). However, the knee is still the most frequently injured joint among all ski injuries (6). Some reports revealed that the injury rate of knees in all injury types was approximately 27%–35% (7). It is also reported that females have a higher incidence of knee injury than male skiers (6).

Bone scintigraphy is a very sensitive technique in the evaluation of different bone and joint disorders (8–11). Many studies have been published about the skeletal changes in baseball, basketball, soccer players, and

other athletes (12–16). These publications have focused especially on joint injuries and stress fractures.

The purpose of this study was to evaluate the role of 99m-technetium methylene diphosphonate (Tc-99m MDP) bone scintigraphy in the detection of joint injuries in asymptomatic competitive alpine ski racers.

### 2. Materials and methods

This study included 20 male asymptomatic alpine ski racers (age range: 18–21 years). Inclusion criteria of the study were established by means of history and physical examination. No history of ski crashes was identified, and upon physical examination subjects revealed no pathologic findings of the lower extremities, especially in the knees. This study was approved by the local ethics committee.

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Tc-99m bone scintigraphy was performed during the active racing season and the inactive training season using 20 mCi Tc-99m MDP. Planar anterior and posterior images of hip, knee, and ankle joints were obtained 4 h after an intravenous injection of radiopharmaceutical, using a dual-head gamma camera interfaced with a dedicated computer (Siemens E.CAM, Siemens Medical Systems, Inc., Hoffman Estates, IL, USA) (Figure). First, all images were interpreted visually by 2 experienced nuclear medicine physicians for visual evaluation of the images. Second, free regions of interest (ROIs) were drawn on hip, knee, and ankle joints and background regions for quantitative evaluation. Mean counts of each ROI were obtained and joint-to-background (Joint/BG) ratios were calculated for each joint. Joint/BG ratios of both right and left joint of hips, knees, and ankles during the active ski season were compared to the Joint/BG ratios during the inactive training period. The Wilcoxon signed-rank test was used for statistical analysis.

### 3. Results

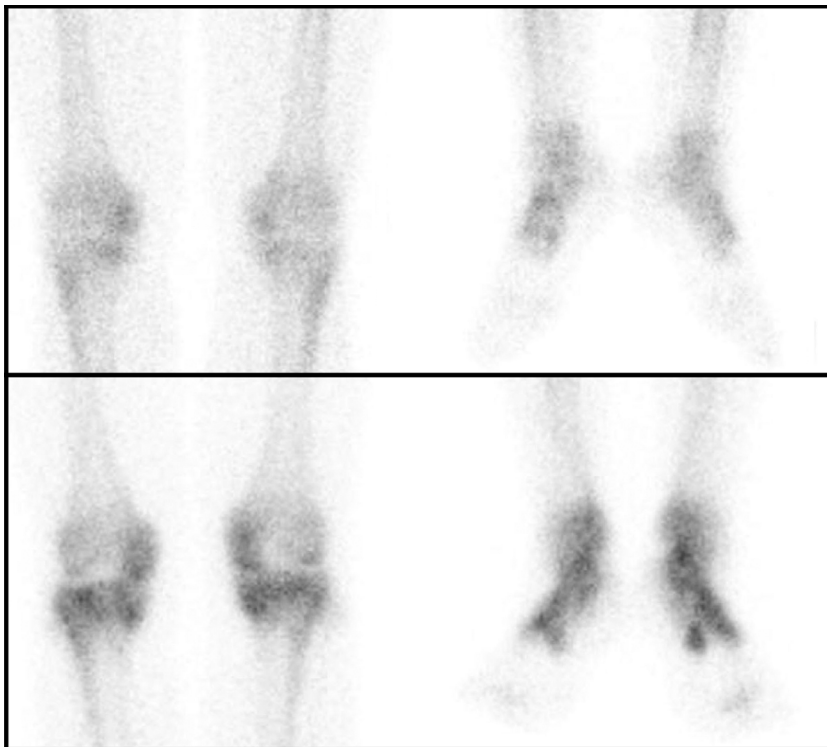
The subjects had neither a history of injury nor symptoms related to an injury. Physical examination of the patients did not reveal any findings suggesting joint injury.

The statistical analysis of the quantitative evaluation results of Joint/BG ratios of the right and left hip, knee, and ankle joints calculated during the active racing period of were significantly higher than those during the inactive period ( $P < 0.005$ ).

Joint/BG ratios of right and left hip, knee, and ankle joints in the competitive and training periods are shown in the Table.

### 4. Discussion

Injuries of the extremities are still some of the most important problems facing alpine ski racers and recreational skiers, despite various attempts at prevention (17). Every year, millions of skiers enjoy skiing all around the world. Since interest in skiing has increased, more ski injuries have been observed in recreational ski areas all over the world (17). However, because the ski injuries of competitive skiers are more serious than those of recreational skiers, more attention is necessary to prevent severe injuries in racers (1). Attempts at reducing injuries consist of 2 major factors. One is the education and training of skiers and the second is the development of new ski equipment, such as boots and bindings, and introduction of advanced ski technologies (1,5).



**Figure.** An anterior planar image shows no abnormal uptake in the knee and ankle joints during training period (upper row, respectively). Increased uptake was shown in the knee and ankle joints during the competitive period (lower row, respectively).

**Table.** Joint/BG ratios in the competitive and training periods.

Joint/BG ratios	Competitive period (mean $\pm$ SD)	Training period (mean $\pm$ SD)
R hip	27.7 $\pm$ 8.0*	12.1 $\pm$ 3.8*
L hip	27.0 $\pm$ 7.5*	12.1 $\pm$ 3.7*
R knee	25.3 $\pm$ 13.2*	7.9 $\pm$ 2.4*
L knee	15.7 $\pm$ 9.8*	3.5 $\pm$ 1.7*
R ankle	15.7 $\pm$ 9.8*	3.5 $\pm$ 1.7*
L ankle	15.3 $\pm$ 9.5*	3.5 $\pm$ 1.8*

\*:  $P < 0.005$ .

The effects of developed ski equipment on reducing injuries in alpine skiers have been investigated widely (5). Investigators have found that injury rates have dropped, while the nature of the injuries has also been transformed over the time (3,4). They observed that lower leg injuries have become less common, while the incidence of knee sprains and upper extremity injuries has become more common. The effect of new ski bindings and rigid ski boots on injury prevention is very obvious. Rigid ski boots restrict tibiotalar and foot movements and reduce the injury rate of ankles and feet (2,18). However, knee joint injuries are the most frequent kind of ski injuries and may lead to serious health problems, especially in competitive ski racers (4,6). The most frequent types of knee injuries among ski injuries are injury of the anterior cruciate ligament or the medial collateral ligament (19). Authors revealed that knee injuries account for approximately 27%–35% of all types of injuries (7).

In the present study we had no patients suffering from knee injuries in the active racing or training periods in

which the scintigraphic images were obtained. Although no patients had joint injuries or crash history in either the active or inactive season, the Joint/BG ratios of hip, knee, and ankle joints obtained in the racing season were significantly higher than those obtained in the training season. These findings suggest that active ski racing might have stressful effects on the lower extremity joints, resulting in increased Tc-99m MDP uptake, even if no detectable injury in the physical examination is present. In accordance with these findings, we claim that bone scintigraphy could detect changes in bone structure resulting from the stress forces of sports activity and joint injuries. The findings of a Tc-99m bone scan may be an early signal of a future event in the joints and may lead the athlete to take preventive measures to avoid undesirable joint damage.

In conclusion, bone scintigraphy may have an important role in detecting injuries in hip, knee, and ankle joints in asymptomatic competitive alpine ski racers and can be used successfully when MRI is unavailable.

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