Osteoarthritis of the knee in retired, elite Australian Rules footballers

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Abstract

Objective: To determine the functional and radiological status of knee joints of retired Australian Rules footballers compared with those of active community members.

Design: Retrospective cohort study.

Participants: Fifty retired elite footballers aged 34–85 years (mean, 53.7 years; SD, 11.4) from four AFL clubs and 50 age-matched controls (35–79 years; mean, 55.7 years; SD, 12.4) who had played no contact sport since their teenage years.

Main outcome measures: Severity of knee functional osteoarthritis as determined by a questionnaire, and assessment of osteoarthritis by posteroanterior weight-bearing radiographs taken of both knees of each participant in 45-degree flexion.

Results: After adjusting for age, height, weight and body mass index, footballers had a significantly greater prevalence (P<0.0001) and severity (P<0.05) of functional and radiological osteoarthritis than controls. Footballers with a history of intra-articular ligamentous and/or meniscal injury (Group 1) had a greater risk of functional osteoarthritis (P=0.002) and radiological (P=0.067) osteoarthritis than those with a history of collateral ligament injury or no injury (Group 2). Compared with controls, the odds of developing moderate to severe levels of functional and radiological osteoarthritis were 6.9 times (95% CI, 1.6–29.7; P=0.01) and 105.0 times (95% CI, 11.8–931.8; P<0.0001), respectively, those in Group 1 footballers and 3.6 times (95% CI, 0.8–16.2; P=0.10) and 17.7 times (95% CI, 2.2–146.2; P=0.0075), respectively, those in Group 2 footballers.

Conclusions: Elite Australian Rules footballers have a significant risk of both functional and radiological osteoarthritis, and a history of intra-articular ligament or meniscal injury increases this risk.

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Methods

Former elite footballers were recruited from four top-echelon Australian Football League (AFL) clubs which provided a list of 65 previous players for whom they had current addresses and phone numbers. Of these, 51 footballers agreed to participate in the study (response rate, 78%). One was excluded as he had been diagnosed with a secondary cause of osteoarthritis. All participants were retired AFL footballers aged between 34 and 85 years (mean, 53.7 years; SD, 11.4).

Fifty age-matched controls who had not played contact sport since their schooldays and had had no knee injury during sporting days were recruited from volunteers at two lawn bowls clubs and from among teachers at two high schools (mean, 55.7 years; SD, 12.4; range, 35–79 years).

Footballers and controls completed a questionnaire that sought information on age, height, weight, family history of osteoarthritis, and on number of games and years of football played, total number of years of other sports played and details of any knee injury. Footballers were divided into two groups according to their self-reported knee-injury diagnoses: Group 1 comprised those with a history of intra-articular ligamentous (anterior or posterior cruciate ligament) and/or meniscal injury; Group 2 comprised those with a history of collateral ligament injury or no injury at all.

To provide an indication of functional osteoarthritis, participants scored the severity of osteoarthritis in their knee joints as nil, minor, moderate, severe or very severe (using a validated questionnaire). To assess osteoarthritis radiologically, in all participants a posteroanterior weight-bearing x-ray was taken of each knee with the knee in 45-degree flexion. Rosenberg et al. found this to be more accurate, more specific (no false positives) and more sensitive (fewer false negatives) than the conventional extension weight-bearing anteroposterior radiographs in assessing osteoarthritis.

We developed a scoring system (shown in Box 1) to grade the severity of radiological osteoarthritis. Radiographs were individually assessed in a blinded
manner by an experienced radiologist and a sports physician. Their findings were correlated to give a score which was agreed upon by both individuals.

Ethical approval for the study was granted by the Committee of Human Ethics in Research and the Radiation Safety Sub-Committee, Austin Hospital, Heidelberg, Victoria. Informed consent was sought from all participants.

Statistical analysis

We analysed the data using Statistical Package for Social Sciences. We compared characteristics of footballers and controls using independent t tests or Mann–Whitney U tests, and levels of functional and radiological ratings between different groups using univariate χ² tests. For functional osteoarthritis ratings, the categories of moderate, severe and very severe were combined for statistical analyses because of small numbers in these categories. We used multiple forward stepwise logistic regression to compare the prevalence of functional and radiological osteoarthritis between different groups. To adjust for potential confounding effects, age, height, weight and body mass index (BMI) were included as covariates in these analyses. Only those variables which contributed significantly to the final model were retained in the analyses. Two-tailed levels of significance were set at P<0.05.

Results

Characteristics of participants

Descriptive data for footballers and controls are shown in Box 2. There was no significant difference in age or in family history of osteoarthritis between the two groups. However, footballers were on average 6.6 cm taller, 12.2 kg heavier and had a BMI 1.8 kg/m² greater than the controls. Footballers and controls had participated in a similar number of years of non-contact sport. Footballers had played a mean of 360.1 (95% CI, 358.7–361.5) games of football over a mean of 19.4 years (95% CI, 18.0–20.8).

The footballers sustained an average of 1.1 acute knee injuries (range, 0–5) during their AFL careers as a result of playing football, compared with 0.1 knee injuries in the control group during their lifetimes. Only 19 footballers (38%) had never sustained a knee injury, compared with 47 controls (94%). Meniscal injury contributed to 46% of the total number of footballers’ knee-injury diagnoses, with the remainder being ligament injuries, comprising medial collateral (19%), anterior cruciate (18%), lateral collateral (9%) and posterior cruciate (8%).

Twenty-one footballers (42%) had surgery to one or both knees at least one occasion as a result of a football injury. Another three (6%) had had surgery to one knee despite never having sustained a knee injury during their career; these operations were for osteoarthritis changes and included an osteotomy, a total knee replacement and a knee arthroscopy. Only three control participants (6%) had injured their knees on one occasion; two had had meniscal injuries and one a medial collateral ligament injury. Two controls had had arthroscopic surgery despite never having had an acute knee injury.

Functional and radiological osteoarthritis

Footballers had a significantly greater prevalence of functional osteoarthritis than controls, even after adjusting for age, weight, height and BMI (P<0.0001). The odds of a footballer developing some degree of functional osteoarthritis were 10.1 times those of controls (95% CI, 3.7–28.1 times). Twenty-nine footballers (58%) reported symptoms of functional impairment, compared with only six control participants (12%). Moderate to very severe levels of functional osteoarthritis were reported by significantly more footballers than controls (Table 2).

Similarly, knees of footballers had a significantly greater prevalence of radiological osteoarthritis than knees of controls. Sixty-six per cent of the footballers’ knees had some signs of osteoarthritis on x-ray, compared with 24% of the control participants’ knees. In the footballers, 25% of knees had severe osteoarthritis, compared with only 1% of knees in control participants (P=0.0001) (Table 2). The odds of a footballer developing some degree of radiological osteoarthritis were 4.0 (95% CI, 1.9–8.2) times those of controls (P<0.0001).

In addition, weight and age were positively related to the prevalence of radiological osteoarthritis. For each one-kilogram increase in weight and each one-year increase in age, the risk of developing radiological osteoarthritis increased by a factor of 1.06 (95% CI, 1.02–1.09; P=0.003) and 1.03 (95% CI, 1.00–1.06; P=0.034), respectively.

The weighted kappa (κ) coefficient for the agreement between the functional and radiological ratings of knee osteoarthritis was 0.78 for the footballers and 0.86 for the controls.

Acute knee injuries and osteoarthritis

There was no significant difference in the presence of functional osteoarthritis between footballers who had any injury to their knees (65%) and footballers who had never injured their knees (48%). There was also no difference in the distribution of functional osteoarthritis ratings between footballers with and without knee injuries.

Radiological signs of osteoarthritis
were present in more knees of footballers that had been injured (78%) than in those that had not (58%). However, this trend was not significant (P = 0.055) when corrected for weight.

Group 1 footballers (intra-articular ligament or meniscal injury) had a significantly greater prevalence of functional osteoarthritis than Group 2 footballers (collateral ligament injury or no injury), even after adjusting for covariates (P = 0.002). The risk of functional osteoarthritis in Group 1 footballers was 8.1 times that of Group 2 footballers (95% CI, 3.5–30.6 times). After adjusting for weight, there was a trend for a greater prevalence of radiological osteoarthritis in the knees of Group 1 footballers than in those of Group 2 footballers (P = 0.067). Severe osteoarthritis was found in 45% and 16% of knees in Group 1 and Group 2 footballers, respectively. Conversely, in 20% of Group 1 knees and 41% of Group 2 knees there were no radiological signs of osteoarthritis.

Compared with control participants, Group 1 footballers were 6.9 times more likely to develop moderate to severe levels of functional osteoarthritis (95% CI, 1.6–29.7; P = 0.01) and 105.0 times more likely to develop radiological osteoarthritis (95% CI, 11.8–931.8; P = 0.0001); for Group 2 footballers, this was 3.6 times (95% CI, 0.8–16.2; P = 0.10) and 17.7 times (95% CI, 2.2–146.2; P = 0.0075), respectively.

**Discussion**

Our results show that retired AFL footballers had a greater prevalence of osteoarthritis, assessed both functionally and radiologically, than a group of active age-matched controls with no exposure to contact sports after their teenage years. These findings were evident even when controlling for other factors such as age, weight, height and BMI which can influence the risk of osteoarthritis. Furthermore, footballers had more severe osteoarthritis than controls.

Current literature suggests that an important determinant of the long-term prognosis of a footballer's knee injury is the type of injury sustained. Intra-articular knee injuries appear to be associated with a greater risk of osteoarthritis. In his analysis of 91 soccer players who had undergone meniscectomy (either partial or total), Muckle found that all had developed radiological changes of knee osteoarthritis within 10 years of meniscectomy. Chantraine, in a study of 81 former soccer players, showed that all 42 knees that had undergone excision of at least one meniscus showed radiological signs of osteoarthritis at follow-up, while only 40 of the 121 unoperated knees showed radiological changes.

Our findings support a relationship between a history of meniscal or intra-articular ligamentous injury and a greater risk of developing functional and radiological osteoarthritis regardless of the medical management players received at the time of injury and thereafter. The large age range of our footballer participants means that their playing careers extended over two vastly different eras of surgical management of knee injuries — the prearthroscopic and the arthroscopic. As it was difficult to clearly divide the footballers into these two eras, we were not able to analyse our results on this basis. However, this would be an interesting comparison.

We acknowledge the potential for misclassification of injury diagnosis in our study as it was not possible to obtain medical verification of the participants’ injury recall. Further, the injuries of some footballers, particularly of older players, may have been incorrectly diagnosed as their knee injuries occurred at a time when tears of the anterior cruciate ligament were generally not well diagnosed and often overlooked.

While we found that intra-articular knee injuries were associated with a greater risk of osteoarthritis, footballers with uninjured knees or with extra-articular injuries were still more likely to develop osteoarthritis than control participants, implying that other causative factors are important in osteoarthritis.

Of relevance to football is the role of impact stress loading and biomechanical factors. In addition to the risk of acute injuries, in ARF the knee is subjected to high loads from running, twisting and jumping. Our footballers had played a large number of games of football over many years. Such loads repeatedly applied over a footballer's playing career could feasibly increase the risk of osteoarthritis of the knee.

Physical characteristics, including height, weight and body mass index, can also contribute to the development of osteoarthritis. Obesity is known to be associated with a higher incidence of osteoarthritis of the knee. In our group of participants, we found weight to be a significant, independent pre-

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### Table 2: Characteristics of the 50 footballers and 50 controls

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Footballers</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean or number (%)</strong></td>
<td><strong>95% CI</strong></td>
<td><strong>Mean or number (%)</strong></td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>53.7</td>
<td>50.5–56.9</td>
</tr>
<tr>
<td>Mean height (cm)</td>
<td>181.4</td>
<td>179.3–183.5</td>
</tr>
<tr>
<td>Mean weight (kg)</td>
<td>89.0</td>
<td>86.1–92.0</td>
</tr>
<tr>
<td>Mean body mass index (kg/m²)</td>
<td>27.0</td>
<td>26.3–27.8</td>
</tr>
<tr>
<td>Mean years of sport, excluding football</td>
<td>25.8</td>
<td>20.7–30.9</td>
</tr>
<tr>
<td>History of knee joint injury</td>
<td>31 (62%)</td>
<td>24.5–37.5</td>
</tr>
<tr>
<td><strong>Severity of functional osteoarthritis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nil</td>
<td>21 (42%)</td>
<td>14–29</td>
</tr>
<tr>
<td>Minor</td>
<td>17 (34%)</td>
<td>11–24</td>
</tr>
<tr>
<td>Moderate/severe/very severe</td>
<td>12 (24%)</td>
<td>6–18</td>
</tr>
<tr>
<td><strong>Severity of radiological osteoarthritis</strong> (Total, 100 knees)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nil</td>
<td>34 (34%)</td>
<td>25–43</td>
</tr>
<tr>
<td>Mild</td>
<td>30 (30%)</td>
<td>21–39</td>
</tr>
<tr>
<td>Moderate</td>
<td>11 (11%)</td>
<td>5–17</td>
</tr>
<tr>
<td>Severe</td>
<td>25 (25%)</td>
<td>17–34</td>
</tr>
</tbody>
</table>

* Difference between footballers and controls significant at P < 0.001.
dictor of radiological osteoarthritis, but not of functional osteoarthritis. Being 10 kg heavier was associated with an approximate 10-fold increase in the risk of signs of radiological osteoarthritis.

In conclusion, we found a higher prevalence and severity of osteoarthritis in the knee joints of retired AFL players than in those of age-matched controls. A history of intra-articular ligament or meniscal injury appeared to place a footballer at higher risk of osteoarthritis. It is to be hoped that developments in sports medicine, including improved recognition and management of acute knee injuries, may decrease the prevalence and severity of osteoarthritis of the knee in those who are now playing Australian Rules football.

Acknowledgements

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References


Books Received


MINIMS script on CD-ROM. MIMS Australia. Sydney: MIMS Australia 1998 ($128.00 [CD-ROM]).

