Asymptomatic Hip/Groin Pathology Identified on Magnetic Resonance Imaging of Professional Hockey Players: Outcomes and Playing Status at 4 Years’ Follow-Up

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Purpose: The purpose of this study was to evaluate the clinical outcomes and playing status of professional hockey players 4 years after they underwent bilateral magnetic resonance imaging (MRI) of asymptomatic hips. Methods: Twenty-one professional hockey players with no previous hip/groin pain underwent hip/pelvis MRI. Each MRI study was evaluated by 3 subspecialty-trained musculoskeletal radiologists for alpha-angle measurement and the presence of adductor—abdominal rectus abnormalities, acetabular labral tears, osteochondral lesions of the femoral head or acetabulum, hip effusion, adjacent muscle contusions or strain injury, and stress fractures. The MRI findings of the players were previously published. In the present study, each athlete was followed up by (1) completion of a questionnaire assessing hip/groin dysfunction at 1 and 2 years’ follow-up and (2) number of games played over the course of the next 4 years. A significant difference in the number of games played was considered when a player missed more than 5 games compared with the index year. Results: We enrolled 21 players in the study. Of these players, 4 had no abnormality bilaterally, 10 had muscle strain and/or tendinosis in 1 or both hips, and 15 had labral tears identified in 1 or both hips. Eight players had a combination of labral tears and muscle strain/tendinosis. Of 21 professional hockey players, 16 (76%) and 14 (67%) were available at 1 and 2 years’ follow-up, respectively. Nineteen of 21 players (90%) continued to play professional hockey at 4 years’ follow-up. The development of any hip and/or pelvis symptoms occurred in only 3 players (14%) within 4 years. Only 1 of the 3 players missed any games because of hip and/or pelvis symptoms. The affected player missed several games because of proximal iliotibial band symptoms that occurred in the third year after MRI. Conclusions: Hip/pelvis pathology is commonly uncovered on MRI of asymptomatic hockey players; however, this pathology does not produce symptoms or result in missed games within 4 years in most players. Level of Evidence: Level IV, therapeutic case series.

Hip and groin ailments are common among athletes, especially in sports such as hockey.1-3

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ip and groin ailments are common among athletes, especially in sports such as hockey.1-3 Diagnosis is difficult given the inter-related and complex anatomy of the low back, abdomen, hips, and pelvis. To establish a specific diagnosis in an athlete presenting with hip and/or groin pain, increasing emphasis has been placed on imaging modalities, especially magnetic resonance imaging (MRI), given its superior contrast resolution, multiplanar images, and ability to directly visualize soft-tissue abnormalities.4 When one is interpreting MRI findings, it is necessary to cautiously correlate their clinical significance given that asymptomatic findings are quite common in both athletes and the general population.5-13

Our group previously investigated the incidence of pelvis and hip MRI findings among asymptomatic collegiate and professional hockey players.14 MRI evidence of either hip or groin pathologic abnormalities was found in 77% (30 of 39 players), with labral tears in 56% (22 of 39 players) and femoroacetabular impingement in 39% (15 of 39 players). In addition, 2
recent studies have shown increased alpha angles among youth hockey players.\textsuperscript{15,16} Although much has been published regardingarthroscopic management of both labral tears\textsuperscript{17-19} and femoroacetabular impingement,\textsuperscript{20-22} the natural history of labral tears and other hip pathology identified on imaging studies has not been well evaluated in hockey players.

In view of the high percentage of asymptomatic MRI findings in hockey players and the remaining questions regarding the natural history of hip/groin pathology, the purpose of this study was to prospectively follow up a previously published series of professional hockey players\textsuperscript{14} and report their clinical outcomes and playing status 4 years after they underwent bilateral MRI of asymptomatic hips. We hypothesized that most hip/groin pathology uncovered on MRI of asymptomatic professional hockey players would not cause significant disability in the short-term.

**Methods**

This prospective, descriptive study was reviewed and approved by the institutional review board, and all participants provided written informed consent before participation. Only active-roster members of a professional American Hockey League team and those willing to undergo bilateral hip MRI were considered for inclusion in the study. Professional hockey players were chosen for this study because of the high prevalence of groin pain in this population.\textsuperscript{1,3} The exclusion criteria were previous injury or surgery on the hip or groin, current hip or groin pain, and known contraindications for MRI. Because 2 of the investigators in the initial study served as the professional team physicians, a data safety—monitoring plan was established before the study initiation. The purpose of the plan was to remedy any unexpected, significant abnormality identified on MRI. Under this plan, another sports medicine physician independent of the study reviewed the clinical and imaging information to determine whether blinding needed to be broken. The team physicians remained blinded to the MRI findings of each athlete unless the decision was made to break blinding.

At the time of initial enrollment, demographic and sport-specific data were collected for each athlete. To assess for disability related to abdominal, groin, or hip pain, a modified Oswestry Disability Questionnaire was completed by each athlete. A 10-point Likert pain scale was used conjunctively to gauge each athlete’s overall subjective sense of abdominal, groin, and/or hip pain. None of the athletes had a pain rating greater than 2 points on the 10-point Likert scale.

Each athlete who enrolled in the study underwent a non-contrast MRI study with a 3.0-T Siemens TIM Trio Magnetom (Siemens Healthcare, Erlangen, Germany) and an 8-element pelvic phased-array coil. For each MRI study, the athlete was positioned supine with the legs in 15° of internal rotation. The protocol for MRI acquisition is presented in Table 1. Despite reports that suggest it may be more accurate,\textsuperscript{23} gadolinium-enhanced arthrography was not used because the athletes were in season and we did not want to cause any potential discomfort that could affect athletic performance.

All patient-specific information was stripped from each MRI study before independent interpretation by 3 subspecialty-trained musculoskeletal radiologists. Studies were analyzed for the presence of adductor—abdominal rectus abnormalities, acetabular labral tears, osteochondral lesions of the femoral head or acetabulum, hip effusion, adjacent muscle contusions or strain injury, and stress fractures. The labrum was considered torn if there was direct visualization of a tear and/or a paralabral cyst was identified. The alpha angle was determined for each player using the technique described by Notzli et al.\textsuperscript{24} Each radiologist reviewed the studies 4 to 6 months after the initial evaluation. Inter-rater and intrarater reliabilities

### Table 1. MRI Acquisition Protocol

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Image Site</th>
<th>Type</th>
<th>Repetition Time/Echo Time (ms)</th>
<th>Section Thickness (mm)</th>
<th>Field of View (cm)</th>
<th>Image Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial</td>
<td>Entire pelvis</td>
<td>T1 weighted, turbo spin echo</td>
<td>600/12</td>
<td>4</td>
<td>40</td>
<td>512 × 512</td>
</tr>
<tr>
<td>Axial</td>
<td>Entire pelvis</td>
<td>T2 weighted, turbo spin echo, fat suppressed</td>
<td>3,000/60</td>
<td>4</td>
<td>40</td>
<td>512 × 512</td>
</tr>
<tr>
<td>Axial</td>
<td>Centered on pubic symphysis</td>
<td>T1 weighted, turbo spin echo, fat suppressed</td>
<td>600/12</td>
<td>3</td>
<td>25</td>
<td>384 × 384</td>
</tr>
<tr>
<td>Sagittal</td>
<td>Centered on pubic symphysis</td>
<td>T1 weighted, turbo spin echo, fat suppressed</td>
<td>600/12</td>
<td>3</td>
<td>25</td>
<td>384 × 384</td>
</tr>
<tr>
<td>Axial</td>
<td>Centered on pubic symphysis</td>
<td>T2 weighted, turbo spin echo, fat suppressed</td>
<td>3,000/60</td>
<td>3</td>
<td>25</td>
<td>384 × 384</td>
</tr>
<tr>
<td>Sagittal</td>
<td>Centered on pubic symphysis</td>
<td>T2 weighted, turbo spin echo, fat suppressed</td>
<td>3,000/60</td>
<td>3</td>
<td>25</td>
<td>384 × 384</td>
</tr>
<tr>
<td>Axial aligned obliquely to femoral neck</td>
<td>Each hip</td>
<td>Proton density weighted, turbo spin echo, fat suppressed</td>
<td>3,000/28</td>
<td>3</td>
<td>15</td>
<td>384 × 384</td>
</tr>
</tbody>
</table>
Table 2. MRI and Clinical Findings

<table>
<thead>
<tr>
<th>Player</th>
<th>MRI Abnormalities</th>
<th>MRI Alpha Angle (°)</th>
<th>Subjective Findings</th>
<th>&gt;5 Games Missed in Season</th>
<th>Playing Status at Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>1 yr</td>
</tr>
<tr>
<td>1</td>
<td>Labral tear, muscle strain</td>
<td>Labral tear, muscle strain</td>
<td>43</td>
<td>60</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>2</td>
<td>None</td>
<td>None</td>
<td>40</td>
<td>41</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
<td>Adductor longus tendinosis, muscle strain</td>
<td>46</td>
<td>45</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>4</td>
<td>Labral tear</td>
<td>None</td>
<td>47</td>
<td>58</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>5</td>
<td>Labral tear, muscle strain, adductor longus tendinosis</td>
<td>Adductor longus tendinosis</td>
<td>52</td>
<td>42</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>6</td>
<td>None</td>
<td>Labral tear</td>
<td>46</td>
<td>41</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>7</td>
<td>Labral tear</td>
<td>Labral tear</td>
<td>58</td>
<td>76</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>8</td>
<td>Muscle strain</td>
<td>None</td>
<td>43</td>
<td>42</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>9</td>
<td>Labral tear</td>
<td>Labral tear</td>
<td>73</td>
<td>70</td>
<td>Low-back pain due to stress fracture; no hip/pelvis symptoms</td>
</tr>
<tr>
<td>10</td>
<td>None</td>
<td>None</td>
<td>59</td>
<td>57</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>11</td>
<td>None</td>
<td>None</td>
<td>39</td>
<td>52</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>12</td>
<td>Labral tear</td>
<td>Labral tear</td>
<td>56</td>
<td>50</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>13</td>
<td>None</td>
<td>None</td>
<td>48</td>
<td>52</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>14</td>
<td>Labral tear</td>
<td>None</td>
<td>55</td>
<td>52</td>
<td>Hip/pelvis pain but “no limitation”</td>
</tr>
<tr>
<td>15</td>
<td>Labral tear</td>
<td>Muscle strain</td>
<td>45</td>
<td>49</td>
<td>No pain or hip/pelvis symptoms</td>
</tr>
<tr>
<td>16</td>
<td>Adductor longus tendinosis</td>
<td>Adductor longus tendinosis, labral tear</td>
<td>44</td>
<td>49</td>
<td>Proximal IT band syndrome—resolved</td>
</tr>
<tr>
<td>17</td>
<td>Labral tear</td>
<td>Muscle strain</td>
<td>46</td>
<td>38</td>
<td>NA</td>
</tr>
<tr>
<td>18</td>
<td>Labral tear, muscle strain</td>
<td>Muscle strain</td>
<td>44</td>
<td>54</td>
<td>NA</td>
</tr>
<tr>
<td>19</td>
<td>Labral tear, adductor longus tendinosis</td>
<td>Labral tear</td>
<td>57</td>
<td>51</td>
<td>NA</td>
</tr>
<tr>
<td>20</td>
<td>Labral tear</td>
<td>Labral tear</td>
<td>53</td>
<td>52</td>
<td>NA</td>
</tr>
<tr>
<td>21</td>
<td>Labral tear, adductor longus tendinosis</td>
<td>Labral tear, adductor longus tendinosis</td>
<td>60</td>
<td>71</td>
<td>NA</td>
</tr>
</tbody>
</table>

IT, iliotibial; MCL, medial collateral ligament; NA, not available.
were calculated. The details of the imaging methods and results of these MRI studies have been previously reported.14

In this study we attempted to follow up this group of professional hockey players clinically to determine their outcome and playing status 4 years after they underwent bilateral MRI of asymptomatic hips. Patient outcome was monitored 2 ways: (1) follow-up surveys at 1 and 2 years and (2) number of games played over the next 4 seasons. Follow-up surveys were provided to each consenting professional athlete at 1 and 2 years, assessing for interim changes in their health; playing status; and specific subjective sense of abdominal, groin, or hip pain using a 10-point Likert pain scale (Appendix Fig 1). By use of a professional hockey database, the number of games played by each professional player was tracked for 4 seasons. Level of play attained at the conclusion of the fourth season was recorded. Deviation in the number of games played by greater than 5 games per year in any year (compared with the year in which the study was initiated) prompted further investigation regarding the cause of absence. Investigation into the cause included recollection of the team physician or evaluation of medical records; if neither of these yielded the cause, a search of the team’s local newspaper was performed. In each case, the cause of absence was determined.

Results

We identified 30 athletes as possible candidates for the study. Of these athletes, 21 (70%) consented to participate whereas 7 declined to participate and 2 were excluded because of prior surgery.

The MRI findings were previously published.14 Table 2 presents a summary of the data for the original 21 players, all originally from the same team, enrolled in the study. A total of 16 players (76%) were available for follow-up at 1 year, whereas 14 (67%) were reached at 2 years. Of 21 professional players, 19 (90%) remained active within 4 years. Neither of the 2 players who retired had any reported hip and/or pelvis symptoms that caused cessation of play. At the end of the 4-year study period, 14 players (67%) remained at the same level of play whereas 4 (19%) advanced to a higher level of play and only 1 (5%) was demoted.

Hip and/or pelvis symptoms developed in 3 players (14%) within the 4-year period. One player with a unilateral labral tear had groin pain during year 1, whereas another player with bilateral labral tears reported “hip tightness” for 1 week during year 2. Neither missed any games related to hip/groin symptoms. A third athlete with a unilateral labral tear and adductor tendinosis had groin pain during year 1 but missed no games during that season; however, this player missed several games during year 3 because of proximal iliobial band symptoms. No player required repeat hip/pelvis imaging or hip-/pelvis-related surgery within the 4-year period.

An asymptomatic labral tear was present in 15 of the 21 athletes (71%) and 22 of the 42 hips (52%) imaged. Eight players had a unilateral labral tear identified on MRI, and 7 players had bilateral labral tears. Among these 15 players, 2 advanced to a higher level of play, 10 remained at the same level, 1 was demoted, and 2 retired. Of 15 players with labral tears, 9 (60%) completed questionnaires at 2 years’ follow-up. Two of these (22%) admitted to having hip/groin pain and only 1 “symptomatic” player missed any games; thus only 2 of the 22 labral tears (9%) became symptomatic at 2 years.

Four players (19%) had no pathology identified on MRI. Only 1 of these players advanced to a higher level of play, whereas 3 remained at the same level within 4 years. None of these players had hip/groin symptoms develop within 2 years or missed any games because of hip/groin pain within 4 years.

Discussion

Multiple studies have shown that hockey players are susceptible to lower abdominal and groin injuries.1–3 These maladies are the leading cause of practice-related injuries among collegiate hockey players2 and account for a cumulative incidence of 20 injuries per 100 players per year among professional hockey players.3 Common adductor—rectus abdominis dysfunction,2,3 tearing of the external oblique aponeurosis,25 and entrapment of the ilioinguinal nerve25 have been cited as the leading causes of pubalgia. These injuries can be difficult to detect with imaging studies and, therefore, are often clinical diagnoses. Recently, intra-articular hip pathology has been increasingly recognized as a potential source of pain among athletic populations.1,15,20

Our group published a study investigating the incidence of pubis and hip MRI abnormalities among asymptomatic hockey players.14 In that study of 21 professional and 18 collegiate hockey players, 36% had pathology involving the common adductor—rectus abdominis complex whereas 64% had hip pathology, including labral tears (56%) and/or osteochondral lesions (18%).14 Given the difficulty in imaging common entities thought to contribute to groin pain and the high incidence of intra-articular pathology among hockey players, the purpose of this study was to provide follow-up of our previous series. Our goals were to determine (1) the incidence of hip and pelvic symptoms at 1 and 2 years’ follow-up and (2) any significant variation in the number of games played within 4 years in a series of professional hockey players with previous asymptomatic findings identified on MRI.

We performed follow-up of only the professional hockey players for 2 reasons. First, because of
budgetary concerns, the college team studied disbanded after 2 years. Second, the number of games played among professional athletes could be tracked more easily using electronic databases and for a longer period because of the finite period of college eligibility. A 4-year follow-up period for variations in the number of games played was selected because of a labor stoppage at the highest level of play in year 5.

A study-specific survey was constructed and administered to determine the patient’s subjective sense of any hip/groin pathology (Appendix Fig 1). Although the use of this questionnaire as the subjective outcome measure may be considered a weakness of this study, no consensus on hip-specific outcome measures for young, active patients was available until after this study began. Currently used outcome measures, such as the International Hip Outcome Tool, and Copenhagen Hip and Groin Outcome Score, were either in their infancy or not available at the time of initiation of this study.

Hip and/or pelvis pain did not develop in the majority of players within 2 years. Among the players who reported pain at 1 and 2 years’ follow-up, no games were missed within those periods. Only 1 player missed any significant time because of hip/pelvis pain, and none required surgery. Although symptoms developed in 22% of players with labral tears identified on MRI compared with none of those with normal MRI studies, we did not have enough players to determine whether this was a significant difference. However, we can state that most players with abnormal MRI findings will not become symptomatic at 2 years’ follow-up and even fewer will miss any games because of hip/pelvis pain.

Our findings suggest that common pathology found on hip and pelvis MRI studies of asymptomatic players often pose few functional limitations at short-term follow-up. Therefore team physicians should exercise caution when interpreting hip and/or pelvis MRI studies to avoid over-treating findings that may not cause pain and disability. Any hip and/or pelvis pathology discovered on imaging studies should be correlated with the patient’s history and physical examination findings to provide optimal treatment.

Limitations

This study has several weaknesses. Because the players were not asked to keep a diary of pain and were questioned only at 12 and 24 months, it is possible that the player responses were subject to recall bias. However, it is unlikely that any athlete who had significant symptoms, especially those that limited performance, would fail to remember. Furthermore, several players may have been reluctant to report symptoms because of financial concerns from potential missed games. Second, only 67% of players initially imaged were able to be contacted at 2 years. Given the transient nature of minor league hockey players, we were unable to obtain more responses. The low numbers of players prevented a meaningful comparison between those with and those without labral tears identified on MRI. Third, it is possible that many players quit or reduced the amount of time playing hockey before they manifested symptoms. Fourth, our study did not involve the use of a validated outcome tool specific for hip pathology. However, when the study was designed, there was no consensus on hip-specific outcome measures for young, active patients. Finally, it is difficult to determine the contribution that hip and/or pelvis pathology had in the development of symptoms in adjacent areas, such as knee and/or low-back pain. Given the high incidence of these entities in the general population and the physicality of hockey, it is unlikely that the pathology seen played a major role.

Conclusions

This work has shown that, despite evidence of hip and/or pelvis pathology on MRI, asymptomatic players usually remain asymptomatic at up to 2 years’ follow-up and, within 4 years, few players miss any games because of hip and pelvis pathology incidentally found on MRI.

References


Appendix Figure 1. Hip follow-up questionnaire. AHL, American Hockey League; NHL, National Hockey League.

Demographic Information:
Time in Season (circle ONE):  First Half  or  Second Half

Position(s) played (list primary position first):

Current Level of Play (circle ONE):  Active  Limited  None
If limited or None, why?

Level of Experience (majority of time spent playing this season - circle ONE):
Collegiate  ECHL  AHL  NHL

Past Medical History:
Previous Surgeries (list ANY along with approximate month and year of the surgery SINCE THE MRI WAS TAKEN):

List any current problems with your (put “none” if you have no current issues):
Back:
Hip:
Thigh:
Knee:
Leg:
Foot:

Current Abdominal or Pelvic Symptoms:

Rate your current Abdominal or Pelvic pain according to the following scale (check ONE):

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>No Pain</td>
<td>Mild Pain</td>
<td>Moderate Pain</td>
<td>Intense Pain</td>
<td>Unbearable Pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

☐  Not Applicable (no pain and no recent symptoms) – if checked, you do not need to fill out the rest of the form

Describe the characteristic of the Abdominal or Pelvic pain (circle ONE):
Sharp  Dull  Stabbing  Burning  Aching  Throbbing

Does the pain radiate to other locations (circle ONE)?  yes/no
If yes, where does it radiate to?
Is it exacerbated by activity (circle ONE):  yes/no
Is it relieved by rest (circle ONE):  yes/no
Is it constant or intermittent (circle ONE)?

What forms of treatments have you used to treat the pain (circle ALL that apply)?
Anti Inflammatories  Physical Therapy  Modified Activity  Ice