Clin Orthop Relat Res (2013) 471:2517–2522
DOI 10.1007/s11999-013-3109-1

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

SYMPOSIUM: ADVANCED HIP ARTHROSCOPY

Labral Injuries of the Hip in Rowers

Robert E. Boykin MD, Eric D. McFeely BA, Kathryn E. Ackerman MD, MPH, Yi-Meng Yen MD, PhD, Adam Nasreddine MA, Mininder S. Kocher MD, MPH

Published online: 26 June 2013

Abstract

Background Injuries of the hip in the adolescent and young adult athlete are receiving more attention with advances in the understanding of femoroacetabular impingement (FAI), labral pathology, and hip arthroscopy. Labral tears have not been well characterized in rowers.

Questions/purposes The purposes of this study were (1) to describe the clinical presentation of labral pathology in rowers; (2) to describe the MRI and radiographic findings of labral pathology in rowers; and (3) to determine the likelihood that a rower with labral injury, treated arthroscopically, will return to sport.

Methods We conducted a review from August 2003 to August 2010 to identify all rowers with MRI-confirmed intraarticular pathology of the hip presenting to our institution. Baseline demographics, symptoms and physical findings, and location of the labral tear with associated pathology, management, and early followup were recorded. The review yielded a total of 21 hips (18 rowers, three with bilateral labral pathology) with a mean patient age of 18.5 years (range, 14–23 years). Most of the rowers (85%) were female and the series included prep school (44%) and collegiate rowers (56%). Eighteen of the 21 hips (85%) eventually underwent arthroscopic surgery at our institution.

Results A large majority of patients had isolated groin pain (71%) and physical findings consistent with impingement (81%). There was no single, dominant location for the labral tears on MRI. Among the 18 patients who had surgery, 10 (56%) returned to rowing, six (33%) never returned, and return data were not available for two (11%) at a mean of 8 months (range, 3–25 months) after surgery.

Conclusions The repetitive motions of the hip required for rowing may be a factor leading to intraarticular labral injuries in the athletes. Underlying anatomic abnormalities of the hip such as FAI may predispose certain patients to these injuries. However, many patients treated arthroscopically did not return to sport at a mean of 8 months after surgery.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.
All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request.
Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at Boston Children's Hospital, Boston, MA, USA.

R. E. Boykin
Sports Medicine, Blue Ridge Bone and Joint Clinic, Asheville, NC, USA

E. D. McFeely, K. E. Ackerman, Y.-M. Yen, A. Nasreddine, M. S. Kocher (✉)
Division of Sports Medicine, Department of Orthopaedic Surgery, Boston Children's Hospital, 300 Longwood Avenue, Boston, MA 02115, USA
e-mail: mininder.kocher@childrens.harvard.edu

Y.-M. Yen, M. S. Kocher
Department of Orthopaedic Surgery, Harvard Medical School, Boston, MA, USA

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Injuries of the hip in the adolescent and young adult athlete have recently received an increasing amount of attention with advances in the understanding of femoroacetabular impingement (FAI), labral pathology, and hip arthroscopy. Labral tears have been described in golfers, hockey players, dancers, karate practitioners, baseball players, and other sports that require repetitive motion of the hip or place the hip at risk for traumatic injury [2, 6, 17, 18]. In a case series by Philippon and colleagues, the majority of professional athletes presenting with labral pathology were participants in hockey, golf, football, soccer, and dance [10]. Although intraarticular injuries represent only a small percentage of total hip athletic injures (5% in NFL players), they account for the largest proportion of days lost from sport [5].

Labral tears have not been previously associated with rowing. The most commonly cited injuries in rowers are those of the lumbar spine and stress fractures of the ribs [4, 9]. A prospective cohort of international rowers illustrated a mean injury rate of 3.67 per 1000 hours with the majority of the injuries being in the lumbar spine (31.8%) followed by the knee (15.9%) and cervical spine (11.4%) [17]. An epidemiologic study examined injuries in elite-level junior rowers, finding that 74% of the reported injuries were secondary to overuse, whereas the remaining 26% were secondary to a single traumatic event [15]. Of the injuries reported, the most common site was the lumbar spine followed by the knee, forearm, and wrist in both sexes. Under the pelvis/groin/buttock/hip/thigh category, eight of 103 traumatic injuries and 25 of 290 overuse injuries were reported, most of which were classified as minor injuries likely representing muscle strains. Many rowers may sustain an injury at some point in their training or competition, but these have historically been regarded as nonmajor injuries [15]. In addition, another study has shown that a number of injuries to rowers occur out of the boat while running, weightlifting, warming up, and/or lifting the boat [1].

As our understanding of hip pathology has improved, we have noted a number of cases of rowers presenting to our clinic over the past decade with intraarticular pathology of the hip involving damage to the labrum. We suggest the mechanism of repetitive hip hyperflexion (with internal rotation in certain circumstances) may predispose rowers to injuries of the labrum, especially those with underlying anatomic abnormalities of the hip. Compared with other injuries in rowing, labral pathology may substantially affect a rower's ability to participate resulting in time lost from sport or the inability to return to crew or sculling. The goals of this study were (1) to describe the clinical presentation of labral pathology in rowers; (2) to describe the MRI and radiographic findings of labral pathology in rowers; and (3) to determine the likelihood that a rower with labral injury, treated arthroscopically, will return to sport.

Patients and Methods

We conducted an institutional review board-approved retrospective database review for all patients presenting to our institution from August 2003 to August 2010 who had or were suspected to have intraarticular labral pathology of the hip. Inclusion criteria comprised any patient presenting to our institution with documented or suspected intraarticular pathology of the hip while actively participating in crew or sculling, no previous hip surgery, and MRI-confirmed pathology. We recorded age at diagnosis, rowing competition level, and a history of locking, catching, or trauma (Table 1). Data regarding whether the patient was a starboard or a port rower were unable to be obtained. We also recorded physical examination variables including painful maneuvers, impingement (flexion, adduction, and internal rotation [IR]), ROM including flexion and IR, and any other relevant positive examination findings (Table 2).

We recorded the size and location of the labral tear in addition to radiographic signs of impingement, hip dysplasia, or any associated findings. The alpha angle and

Table 1. Patient demographics

Number of labral injuries, hips (number of patients)	21 (18)
Female:male, number (%)	18 (85.0):3 (15.0)
Mean age at treatment (years) ± SE (range)	18.5 ± 0.6 (14–23)
Crew level, number (%)	
Prep school	8 (44.0)
Collegiate	10 (56.0)
Location of pain, number (%)	
Isolated groin	15 (71.0)
Isolated lateral	2 (10.0)
Groin/lateral	3 (14.0)
Groin/buttock	1 (5.0)
Locking:no locking, number (%)	6 (28.6):15 (71.4)
Trauma:no trauma, number (%)	1 (5.0):20 (95.0)

Table 2. Physical examination and imaging summary

Physical examination	
Pain with flexion:pain with extension, number (%)	21 (100):0 (0)
Positive impingement sign (flexion, adduction, internal rotation), number (%)	17 (81.0)
Radiology	
Left:right, number (%)	13 (61.9):8 (38.1)
Location, number (%)	
Anterior	5 (23.8)
Lateral	6 (28.6)
Anterolateral	10 (47.6)
Femoroacetabular impingement, number (%)	
Cam	10 (47.6)
Mixed (cam + pincer)	5 (23.8)
Arthroscopy	
Dynamic isolated cam impingement	3 (16.7)
Dynamic isolated pincer impingement	0 (0)
Dynamic mixed impingement	3 (16.7)

lateral center-edge angle were calculated on initial plain radiographs. For those patients who received a subsequent operative procedure, we reviewed the operative notes to determine the procedure, and patients requiring a revision procedure were noted in addition to time to revision if applicable. The most recent clinic notes were examined and subjective followup was recorded along with time at the most recent followup. We calculated eventual return to rowing based on the most recent clinic notes or correspondence at a mean of 8 months after surgery (range, 3–25 months).

Twenty-four rowers with subjective and physical examination findings suspicious for intraarticular pathology of the hip were identified from the database out of 12,251 new patients presenting to our institution over the 7-year period. Six patients were excluded because one was recently postoperative from an outside institution, one patient had a previous periacetabular osteotomy with labral excision, two had been recommended to undergo an MRI but not completed, and two coxswains were excluded. Three cases were bilateral yielding a total of 21 hips. Of these, 13 were on the right and eight on the left. The mean patient age was 18.5 years (range, 14–23 years; median age, 19 years; interquartile range, 5 years) with 85% female and 15% male patients. This series included eight prep school rowers (44%) and 10 collegiate rowers (56%). Of the 18 hips that had a hip arthroscopy, 11 (61%) underwent isolated débridement of the labrum, one with labral débridement and acetabular chondroplasty, two with labral débridement and femoral head/neck osteochondroplasty, one with labral repair and femoral head/neck osteochondroplasty, three (16%) with débridement, femoral head/neck osteochondroplasty, and acetabular rim trimming. A dynamic examination was performed at the time of hip arthroscopy to determine if the radiographic impingement was significant. In those cases in which there was dynamic impingement, the bony lesion was addressed.

Results

A large majority of patients presented with isolated groin pain (71%) and physical findings consistent with impingement (positive anterior impingement sign: flexion, adduction, IR) (81%). Catching and locking were present in 26% of the rowers. A discrete traumatic event was reported by one of the hips (5%), whereas the remaining 20 hips recalled a more gradual onset of pain. All patients reported their pain was worse with activity, specifically while crewing Passive ROM data were available for 17 (81%) and included an average of 101° of flexion (range, 90°–130°) and 22° of IR (range, 0°–45°) at 90° of flexion. There was no clinical evidence of athletic pubalgia or leg length discrepancy in any of the patients (Tables 1, 2).

There was no single, dominant location for the labral tears on MRI. Review of the MRI showed all patients had some degree of labral pathology in the anterior half of the acetabulum ranging from degenerative tearing to more complex longitudinal tears. No posterior labral injuries were noted in this series. Overall MRI revealed 10 anterolateral tears, six lateral tears, and five anterior tears. Fifteen of the patients had degenerative or partial tearing and five had full-thickness or complete tears. Radiographic impingement was defined as any sign of cam or pincer impingement on plain films or MRI, an alpha angle on plain radiographs of $> 50°$ (cam impingement) or a lateral center-edge angle of $> 40°$, a crossover sign, or coxa profunda/protrusio (pincer impingement). Using these criteria, 15 (71.4%) hips had radiographic impingement with 10 pure cam lesions and five mixed cam/pincer. The average alpha angle was 52.7° (range, 38°–71°) and the average lateral center-edge angle was 34.6° (range, 22°–49°). Eight patients also had an associated injury while rowing, including either lower back pain (50%) or ipsilateral trochanteric bursitis (50%). These associated injuries were successfully treated nonoperatively and were not felt to affect return to sport.

Among the 18 patients who had surgery, 10 (56%) returned to rowing at a mean of 8 months (range, 3–25 months) after surgery. Two (11%) underwent a subsequent revision hip arthroscopy at our institution (one each at 6 and 18 months) consisting of repeat labral débridement

and synovectomy. One of these patients had a discrete traumatic event postoperatively leading to a recurrent tear and the other had recurrence of symptoms after returning to rowing (both had complete relief of their pain after revision arthroscopy). These patients did not have dynamic impingement at the time of the primary or revision surgery. Overall 10 (56%) patients returned to competitive rowing, six (33%) never returned, and return data were not available or pending for two (11%).

Discussion

Traumatic and overuse injuries in rowers have been described in the literature with most studies citing high rates of minor injuries to the lumbar spine, knee, wrist, and ribs [4, 15, 17]. Injury to the hip has rarely been reported and is typically grouped with muscle strains of the thigh or buttocks. With the advent of the routine use of MRI to evaluate the hip and advances in the understanding of both intraarticular and extraarticular hip pathology, we have noted a number of rowers who have presented to our institution with a similar constellation of complaints and clinical examination findings consistent with intraarticular pathology of the hip. Therefore, the purposes of this study were (1) to describe the clinical presentation of labral pathology in rowers; (2) to describe the MRI and radiographic findings of labral pathology in rowers; and (3) to determine the likelihood that a rower with labral injury, treated arthroscopically, will return to sport.

The limitations of this study include the fact that this was a retrospective review of a prospectively collected database. The pathology in rowers was a trend we noted over time in a relatively small group of patients and therefore a retrospectively designed study was necessary. Inherent to any retrospective review, we were limited by the quality of data that was collected on initial and preoperative visits. For instance, as a result of a lack of standardization of strength measurements (no dynamometer was used), we cannot accurately report functional strength deficits. Another major limitation was the lack of validated outcome instruments. This patient population is highly mobile and difficult to locate; therefore, only subjective short-term followup was obtained. Because a major purpose of this study was not to examine the clinical outcomes, but rather to assess return to play, we believe short-term followup is adequate for this purpose. We believe the length of followup attained is sufficient to assess whether a highly motivated group of young athletes was able to return to crewing. Although these limitations certainly limit the detail of the evaluation, we believe this does not detract from the overall purpose of our study, which centers around describing the clinical and radiographic presentation of this pathology in a subset of specific athletes and examining the impact this has on their ability to return to sport.

The underlying bony anatomy in disorders such as a slipped capital femoral epiphysis, Legg-Calvé-Perthes disease, hip instability, or FAI (cam and pincer type) may predispose patients to the development of degenerative or traumatic labral or chondral pathology [11, 16]. Degeneration and tearing of the labrum are typically noted to have a predisposition for the anterosuperior region secondary to impingement from FAI in addition to decreased biomechanical properties as compared with the posterior labrum [14]. Although there are limited data in the literature concerning this topic, of the hips in this series, 81% had a positive anterior impingement sign and the majority of hips presented with isolated groin pan as the primary complaint (71%). Only one patient reported a history of a discrete trauma to the hip; therefore, we believed the vast majority of these labral injuries were from overuse and the repetitive motion of rowing, especially in patients with underlying anatomic abnormalities. Based on the clinical presentation, we believe the mechanism of injury in rowers may be secondary to repeated hyperflexion of the hip. In crew, or sweep, rowing, rowers each have one oar and compress the hip in flexion as they move the seat up the slide to place the blade in the water at the catch before driving the blade through the water. The position of the sweep rower at the catch also requires increased spinal rotation and hip compression on the side where the blade enters the water. As the rower drives the oar through the water by pulling on the oar, extending the legs and extending the back, the hips both go from extreme flexion to extension. This motion of the rowing stroke is repeated hundreds to thousands of times per practice with a standard 2000-meter race averaging approximately 250 strokes alone. In sculling, the rower has two oars and the motion is more symmetrical. At the catch, the hips are equally compressed, and again, through the drive. the rower moves into hip extension to the finish (Fig. 1). In our study, the majority of the patients were female and recent biomechanical data have demonstrated sex differences in trunk and pelvic kinematics with rowing, which may account for the discrepancy [8].

Previous studies have cited frequent injuries in rowing but a low percentage of those to keep a rower out for more than 1 month [15]. In our series of 21 hips, the labral injuries to the hip were substantial and the pain severe enough that even after periods of conservative management, most opted for a surgical procedure. The paucity of data in other reports may be influenced by a previous limited understanding of hip injuries in athletes and inadequate imaging studies. All patients in our study were evaluated with MRI and therefore damage to the intraarticular structures could be accurately assessed. This

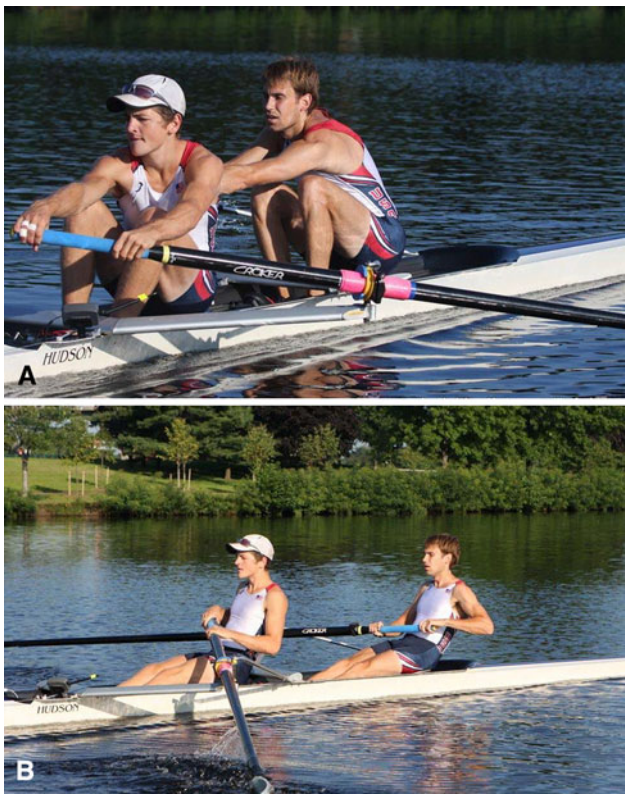

Fig. 1A–B Pair rowing at the catch demonstrating hip flexion (**A**) and a pair rowing at the finish after the drive with extension of the hips (**B**). Photos courtesy of Igor Belakovskiy; printed with permission.

revealed all anterolateral, anterior, or lateral tears without evidence of posterior tearing, which is consistent with our proposed mechanism of injury. Using our aforementioned criteria, 15 (71.4%) hips had radiographic impingement with 10 pure cam lesions and five mixed cam/pincer. The average alpha angle was 52.7° (range, 38°–71°) and the average lateral center-edge angle was 34.6° (range, 22°–49°). We did, however, note that only six of these 15 had clinically significant impingement on a dynamic arthroscopic examination.

Most of the experience with hip arthroscopy has been in adults; however, it has been shown to be safe in the pediatric and adolescent age groups with minimal complications [7, 13]. Although there are less data in younger patients, a 10-year followup in adults demonstrated débridement of symptomatic labral tears in adults to have good outcomes long term [3]. In addition, an early followup study by Philippon et al. revealed major improvement in function and excellent patient satisfaction after hip arthroscopy for FAI [12]. More recent studies have demonstrated improved clinical results with labral preservation techniques over débridement alone. We have changed our practice since the time of this study to reflect the newer data and try to repair the labrum when possible. It is feasible that the rate of return in this series could have been higher with labral repair procedures. This should be considered a limitation to this study as techniques and data continue to evolve. It must also be noted that repeat injury to the labrum is a real possibility and may occur from trauma or after returning to rowing, as seen in two of our patients who required revision. Our limited early followup data suggest that the rate of return to competitive rowing is only moderate with 56% of the patients returning to competitive rowing. The social factors influencing return to play were unable to be calculated and may have led to a lower number. For instance, some of these patients were finishing a high school rowing career and not intending to proceed with crewing in college.

Labral tears have been described in other sports but have not been well characterized in a population of rowers. We believe the repetitive hip flexion required for the sport may be one of several mechanisms causing intraarticular labral pathology of the hip with underlying anatomic abnormalities of the hip predisposing certain patients to injury. This injury should be considered in adolescent and young adult rowers presenting with groin pain in addition to those with signs of impingement and pain on physical examination. These injuries are initially managed nonoperatively but many patients remain symptomatic. In refractory cases, the pathology in rowers may be treated arthroscopically with a moderate rate of return to competitive rowing. Future studies concerning evolving techniques, including labral repair, may lend a higher rate of return for these athletes.

References

1. Brosh S, Jenner JR. Injuries to rowers. *Br J Sports Med.* 1988; 22:169.
2. Byrd JW. Hip arthroscopy in athletes. *Instr Course Lect.* 2003; 52:701–709.
3. Byrd JW, Jones KS. Prospective analysis of hip arthroscopy with 10-year followup. *Clin Orthop Relat Res.* 2010;468:741–746.
4. Dragoni S, Giombini A, Di Cesare A, Ripani M, Magliani G. Stress fractures of the ribs in elite competitive rowers: a report of nine cases. *Skeletal Radiol.* 2007;36:951–954.
5. Feeley BT, Powell JW, Muller MS, Barnes RP, Warren RF, Kelly BT. Hip injuries and labral tears in the national football league. *Am J Sports Med.* 2008;36:2187–2195.
6. Hickey GJ, Fricker PA, McDonald WA. Injuries to elite rowers over a 10-yr period. *Med Sci Sports Exerc.* 1997;29:1567–1572.
7. Kocher MS, Tucker R. Pediatric athlete hip disorders. *Clin Sports Med.* 2006;25:241–253, viii.
8. Ng L, Campbell A, Burnett A, O'Sullivan P. Gender differences in trunk and pelvic kinematics during prolonged ergometer rowing in adolescents. *J Appl Biomech.* 2012 Jul 6 [Epub ahead of print].
9. O'Kane JW, Teitz CC, Lind BK. Effect of preexisting back pain on the incidence and severity of back pain in intercollegiate rowers. *Am J Sports Med.* 2003;31:80–82.
10. Philippon M, Schenker M, Briggs K, Kuppersmith D. Femoro-acetabular impingement in 45 professional athletes: associated

pathologies and return to sport following arthroscopic decompression. *Knee Surg Sports Traumatol Arthrosc.* 2007;15:908–914.
11. Philippon MJ. The role of arthroscopic thermal capsulorrhaphy in the hip. *Clin Sports Med.* 2001;20:817–829.
12. Philippon MJ, Yen YM, Briggs KK, Kuppersmith DA, Maxwell RB. Early outcomes after hip arthroscopy for femoroacetabular impingement in the athletic adolescent patient: a preliminary report. *J Pediatr Orthop.* 2008;28:705–710.
13. Siparsky PN, Kocher MS. Current concepts in pediatric and adolescent arthroscopy. *Arthroscopy.* 2009;25:1453–1469.
14. Smith C, Masouros S, Hill A, Amis A, Bull AM. A biomechanical basis for tears of the human acetabular labrum? *Br J Sports Med.* 2009;43:574–578.
15. Smoljanovic T, Bojanic I, Hannafin JA, Hren D, Delimar D, Pecina M. Traumatic and overuse injuries among international elite junior rowers. *Am J Sports Med.* 2009;37:1193–1199.
16. Wenger DE, Kendell KR, Miner MR, Trousdale RT. Acetabular labral tears rarely occur in the absence of bony abnormalities. *Clin Orthop Relat Res.* 2004;426:145–150.
17. Wilson F, Gissane C, Gormley J, Simms C. A 12-month prospective cohort study of injury in international rowers. *Br J Sports Med.* 2010;44:207–214.
18. Winzen M, Voigt HF, Hinrichs T, Platen P. [Injuries of the musculoskeletal system in German elite rowers] [in German]. *Sportverletz Sportschaden.* 2011;25:153–158.