



Injuries Among Adolescent Water Polo Players: Demographics, Evaluation, and Management

Matthew J Orringer, BA^{1*} and Nirav K Pandya, MD²

¹School of Medicine, University of California, San Francisco, USA

²Department of Orthopedic Surgery, University of California, San Francisco, USA



Abstract

Background: The combination of swimming, throwing, and physical contact in water polo places players at risk for a range of injuries. Prior research has demonstrated high rates of head and shoulder injuries among competitive water polo players. However, there is limited injury data regarding adolescent water polo players.

Methods: We identified patients under the age of 18 with water polo-related concerns treated at the sports medicine divisions at our institution across a five-year span. History, physical examination, imaging, diagnoses, and treatment outcomes were recorded.

Results: We identified 56 adolescent water polo players (mean age = 15.3 years). Injuries to the shoulder (23) and head (11) were most common. Concussion (11), rotator cuff pathology (8), shoulder instability (6), and scapular pathology (6) were the most common diagnoses. Mechanisms of injury included throwing (14), swimming (12), and physical contact with opponents or the ball (12). The most frequently employed diagnostic evaluation protocol included a history and physical exam with an x-ray (18). Physical therapy (40) and rest from sports (29) were the most frequently recommended treatments with surgery being rarely indicated (6).

Conclusions: Among our cohort of patients, injuries to the head and shoulder were the most commonly seen in adolescent water polo players. Throwing, swimming, and acute unexpected contact were all frequently described by patients as contributing to their injuries. Providers and coaches should be aware of the unique physical demands of water polo as well as the most common injuries and medical management of these athletes.

Keywords

Adolescent, Water polo, Injury, Sports medicine, Pediatrics

Introduction

Water polo is a fast-growing sport in the United States with over 50,000 USA Water Polo members in 2019 [1]. In fact, since 2009, the number of American high school water polo players has increased by 8.8% for men and 18% for women [1]. Water polo is played in a 30 m x 20 m course for men and a 25 m x 20 m course for women. It consists of two teams of seven players, six players in the “field” and one goalkeeper. The game combines elements of swimming, throwing, and physical combat to win possession of the ball [2]. The game is typically played in four quarters with the winning team being that which scores more goals.

The unique physical demands required to train for and compete in water polo put athletes at risk for a wide range of injuries, both over use and traumatic. A systematic review of water polo-associated injuries in athletes of all ages found that traumatic, in-game injuries were more likely to affect the head and hands of players while the shoulders were more

susceptible to long-term training-related injuries [3]. One study of over 1500 water polo players found that the lifetime prevalence of concussions for male athletes was 30.8% and the prevalence for female athletes was 45.5% [4]. Numerous studies have further reported a high rate of head trauma in water polo due to unexpected contact with the ball or opposing players [5-7].

Upper extremity injuries, especially those to the shoulder, are also common among water polo players with one study

***Corresponding author:** Matthew J Orringer, School of Medicine, University of California, San Francisco, USA

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finding a 10-year prevalence rate of 98.4% for shoulder injuries among nearly 500 athletes [8]. Unexpected contact with opposing players or the ball can lead to acute subluxation or dislocation events [9]. In addition, chronic injuries, such as rotator cuff tendinopathies, may result from swimming training or overuse from throwing practice [3,9-12].

The unique egg-beater kick utilized in the sport may contribute to lower extremity injuries in water polo players [13]. The egg-beater motion is similar to a breaststroke kick. It involves the lower legs moving in a rotary fashion such that the left leg moves clock wise and the right leg moves counter clock wise [11]. There is evidence that hip and groin pain is common among water polo players [8,14]. Additionally, injuries to the knee have been described including meniscus injuries and patellofemoral pain syndrome [11].

Despite the growing popularity of water polo among young athletes, there is limited data describing the most common water polo-related injuries and the diagnostic evaluation and treatment process for this patient population. This is particularly important as the process of skeletal maturation places the pediatric and adolescent population at increased risk. The present study aims to describe common injuries associated with playing water polo among pediatric and adolescent patients. In addition, this paper will report on the diagnostic evaluation methods used by physicians caring for these athletes as well as the treatment protocols that were recommended.

Methods

Data Extraction

The electronic medical record at our institution was queried using Epic's Clarity database (Epic Systems Corporation, Madison, Wisconsin). This was used to identify patients who sought care at our clinics for a water polo-associated injury. We used Structured Query Language code to program our data extraction. We first identified the 481 resident and attending physicians who had worked in the orthopedic surgery or sports medicine clinics since January 1st, 2016 at our institution. We then extracted patient medical record numbers of those with a history and physical examination (H&P) or progress note from one of these 481 providers between the dates of January 1st, 2016 and June 15th, 2021. Only patients who were 18 years of age or younger at the time of their first visit to the provider were included. We limited the search to only notes that included the term "water polo" which provided us with 1,000 notes from 265 patients for chart review analysis.

We then individually reviewed the charts of these patients. The keyword "water polo" was searched within each of the 265 patients' charts in order to find the notes that specifically mentioned this term. These notes were then read in order to evaluate the context in which the term was mentioned as well as the nature of the visit for the patient. Patients were only included in the final analysis of the study if their injuries were directly associated with playing in or training for water polo competition. Patients were not included if their injuries or chief concerns were related to playing other sports or due to non-sports related pathologies.

Patient data were collected from the electronic medical record including patient age at the time of first encounter with the provider, gender, the cause of the injury and/or subsequent aggravating factors, the time course and location of the injury, any specific diagnoses made by the provider, the diagnostic work-up performed by the medical team, the treatment strategies employed (including whether or not the patient underwent an operation), and whether the patient was seen again for follow-up. These data were stored in a RED Cap (Research Electronic Data Capture) database [15,16]. Institutional Review Board (IRB) approval was received from our institution prior to initiation of the data extraction process.

Analysis

Patients were grouped into one of four subgroups depending on the location of their injury: Upper extremity, lower extremity, head, and back. Statistical analysis included calculation of mean values for age and BMI for each injury location-based subgroup of patients as well as the full cohort of patients. Data regarding patient gender, injury location, chronicity and diagnosis, diagnostic testing, treatment strategies, and follow-up appointments were also collected for each subgroup of patients. Analyses were performed using Stata MP 16 analytical software (StataCorp, LLC, College Station, Texas).

Results

Fifty-six patients were seen by orthopedic surgeons or sports medicine physicians due to water polo-associated injuries based on the above criteria. Patients were an average age of 15.3 years old (SD: 1.5, range 11-17). Thirty-three of the young athletes were female (58.9%) (Table 1).

Upper Extremity Injuries

Demographics

Thirty-one of the fifty-six patients sought care due to upper extremity injuries. These patients were an average age of 15.2 years old at initial evaluation (SD: 1.6, range: 11-17) and 17 of the 31 patients were female (54.8%) (Table 1).

Aggravating Factors

Mechanisms of injury and ongoing aggravating factors included throwing (14 patients), swimming (11), and acute movements of the upper extremity during competition such as an opponent pulling on the arm of a patient (4) (Table 2).

Injury Time Course, Location, and Specific Diagnoses

Fifteen of the thirty-one upper extremity injuries were acute in nature (48.4%) (Table 3). Twenty-three patients sought care for shoulder-related pathologies with two patients seeking care for bilateral shoulder pain (74.2%). Three patients presented with finger concerns, two with elbow pain, two with scapular pathologies, and one with wrist pain. Many patients were given multiple diagnoses by their providers. The most common diagnoses included rotator cuff pathology (8), shoulder instability and dislocation (6),

Table 1: Demographics.

		Upper extremity (n = 31)	Lower extremity (n = 13)	Head (n = 11)	Back (n = 1)	Total (n = 56)
Gender	Male	14	6	3	0	23
	Female	17	7	8	1	33
Mean age (SD)		15.2 (1.6)	15.3 (1.3)	15.6 (1.7)	16	15.3 (1.5)

Table 2: Aggravating Factors and Causes of Injuries.

	Upper extremity	Lower extremity	Head	Back	Total
Throwing	14	0	0	0	14
Swimming	11	0	0	1	12
Acute hit from ball or opponent	1	0	11	0	12
Egg-beater kicking	0	9	0	0	9
Acute arm motion	4	0	0	0	4
Overhead activity (i.e., putting on a shirt)	3	0	0	0	3
Concentrating/schoolwork	0	0	3	0	3
Light/noise exposure	0	0	3	0	3
Sitting/positional changes	1	1	0	0	2
Lifting weights/cross-training	2	0	0	0	2
Walking/running	0	2	0	0	2
Acute increase in water polo training workload	0	1	0	0	1

Table 3: Time course.

	Upper extremity	Lower extremity	Head	Back	Total
Acute	15	3	11	0	29
Chronic	16	10	0	1	27

and scapular pathology (6). See Table 4 for a full summary of diagnoses.

Diagnostic Evaluation

The most common diagnostic imaging modality utilized by the treating medical team included X-rays in addition to a thorough history and physical examination with 12 of the 31 patients undergoing this combined evaluation. Eight patients underwent an MRI in addition to X-rays and a history/physical examination (Table 5).

Treatment Protocol, Surgery, and Follow-Up

The most common recommendation for upper extremity injuries was physical therapy (27 patients). Physicians also commonly recommended rest from sports (13) (Table 6). Three patients underwent surgical treatment. One patient underwent a labral repair operation for chronic shoulder instability associated with throwing the water polo ball. Two patients underwent elbow arthroscopy with loose body removal and chondroplasty. Each of these patients described throwing as the major aggravating factor for their injuries. Twenty of the thirty-one patients visited the orthopedic or sports medicine clinics for a follow-up visit (64.5%) (Table 6).

Lower Extremity Injuries

Demographics

Thirteen patients visited orthopedic and sports medicine physicians for lower extremity concerns. Patients were an average age of 15.3 years old (SD: 1.3, range 13-17). Seven of the thirteen patients were female (53.8%) (Table 1).

Aggravating Factors

The most common mechanism of injury was egg-beater kicking (9 patients), (Table 2).

Injury Time Course, Location, and Specific Diagnoses

Ten of the thirteen lower extremity injuries analyzed were chronic in nature (76.9%) (Table 3). Ten patients presented with knee injuries (76.9%) while four presented with hip pain. One patient presented with both hip and knee concerns related to water polo. The most common lower extremity diagnoses for our cohort of patients were femoroacetabular impingement syndrome (3), hip labral pathology (3), patellar instability (3), and patellofemoral dysfunction (3) (Table 4).

Diagnostic Evaluation

Each of the thirteen patients with lower extremity injuries underwent at least one form of imaging in addition to a history and physical exam. Six patients received an X-ray study, one underwent an MRI, and six had both X-rays and MRI in addition to the history/physical examination (Table 5).

Treatment Protocol, Surgery, and Follow-Up

Physical therapy was recommended for 11 of the 13 patients with lower extremity injuries (84.6%). Rest from sports was the next most common treatment protocol prescribed by physicians with seven patients being given this recommendation (53.8%) (Table 6). Surgical treatment was performed in three patients with lower extremity injuries.

Table 4: Diagnoses.

Diagnosis	Number of Patients	General location
Concussion	11	Head
Rotator cuff pathologies	8	Upper Extremity
Shoulder instability (including dislocation)	6	Upper Extremity
Scapular pathologies	6	Upper Extremity
Fracture	5	Upper Extremity
Non-fracture bony pathology or inflammation (including epiphysitis, osteochondral defect)	5	Upper Extremity
Shoulder labral pathology	3	Upper Extremity
Femoroacetabular impingement syndrome (FAIS)	3	Lower Extremity
Hip labral pathology	3	Lower Extremity
Patellar instability	3	Lower Extremity
Patellofemoral dysfunction	3	Lower Extremity
Shoulder impingement	2	Upper Extremity
Sub acromial bursitis	2	Upper Extremity
Osgood-Schlatter Disease	2	Lower Extremity
Lower extremity muscle strain	2	Lower Extremity
Upper extremity muscle strain	1	Upper Extremity
Meniscus tear	1	Lower Extremity
Ganglion cyst near meniscus	1	Lower Extremity
L5-S1 paracentral disc herniation	1	Back

Table 5: Diagnostic Evaluation.

	Upper extremity	Lower extremity	Head	Back	Total
History/Physical exam (H/P) only	5	0	0	0	5
H/P + X-ray	12	6	0	0	18
H/P + MRI	5	1	0	0	6
H/P + X-ray + MRI	8	6	0	1	14
H/P + X-ray + ultrasound	1	0	0	0	1
H/P + CT scan	0	0	1	0	1
H/P + BESS ¹	0	0	2	0	2
H/P + ImPACT ²	0	0	6	0	6
H/P + SCAT5 ³	0	0	7	0	7
H/P + Sway test	0	0	2	0	2
H/P + VOMS ⁴	0	0	1	0	1

¹Balance Error Scoring System Test

²Immediate Post-Concussion Assessment and Cognitive Test

³Sport Concussion Assessment Tool 5th Edition

⁴Vestibular/Ocular Motor Screening Assessment.

Table 6: Treatment recommendations and follow-up.

	Upper extremity	Lower extremity	Head	Back	Total
Physical therapy	27	11	1	1	40
Rest from sports	13	7	9	0	29
NSAIDs	6	3	1	0	10
Cognitive rest	0	0	8	0	8
Conservative management (icing, massage, etc.)	6	1	0	0	7
Sling/Brace/Cast/Boot	6	1	0	0	7
Surgery	3	3	0	0	6
Refer to psychiatry re: concentration	0	0	1	0	1
Any follow-up appointment	20	5	6	1	32
One follow-up visit	12	2	3	0	17
Two follow-up visits	3	1	2	1	7
3 or more follow-ups	5	2	1	0	8

One patient underwent a lateral meniscus repair for an acute injury associated with egg-beater kicking. Another athlete received a lateral release and medial imbrication operation with chondroplasty for chronic patellofemoral pain and instability in order to improve the alignment of the patella. A third patient underwent a hip labral tear repair with femoroplasty of a Cam lesion and acetabuloplasty of a Pincer lesion for chronic femoroacetabular impingement syndrome with a labral tear. Five of the thirteen patients returned to the clinic for a follow-up visit (38.5%) (Table 6).

Head Injuries

Demographics

Eleven patients (mean age: 15.6 years, SD: 1.7, range 13-17) sought care due to head injuries associated with playing water polo. Eight of the eleven patients were female (72.7%) (Table 1).

Aggravating Factors

Each of the 11 patients' injuries resulted from acute hits to the head either by the water polo ball or from opponents. Following these injuries, patients noted light and noise sensitivity (3 patients) and discomfort when concentrating or doing school work (3) (Table 2).

Injury Time Course, Location, and Specific Diagnoses

All of the eleven injuries to the head were acute in nature (100%) (Table 3). Each of the eleven patients were diagnosed with a concussion (Table 4).

Diagnostic Evaluation

In addition to a thorough neurological exam, patients with head injuries received a range of additional testing. Only one patient received imaging (a CT scan). However, seven patients were evaluated with the Sport Concussion Assessment Tool (SCAT5). In addition, six patients underwent the Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) (Table 5).

Treatment Protocol and Follow-Up

The most common medical management strategies recommended by providers were cognitive rest (8) and physical rest (9). One patient was referred to physical therapy for neck pain and one was referred to psychiatry for persistent difficulty with concentration (Table 6). No patients underwent surgical management for their head injuries. Six of the eleven patients went to a follow-up visit with their sports medicine provider (54.5%) (Table 6).

Back Injuries

Demographics

One 16-year-old female patient sought care for a back injury related to water polo (Table 1).

Aggravating Factors

The patient noted back discomfort with swimming during water polo practice (Table 2).

Injury Time Course, Location, and Specific Diagnoses

The back injury for which the one patient sought care was chronic in nature (Table 3). She was diagnosed with an L5-S1 paracentral disc herniation (Table 4).

Diagnostic Evaluation

An X-ray study and MRI were completed in addition to a history and physical examination for the one athlete with a back injury (Table 5).

Treatment Protocol and Follow-Up

Physical therapy was recommended for treatment of the patient's back injury. Surgical treatment was not indicated. The patient subsequently required follow-up visits with her provider on two separate occasions (Table 6).

Discussion

The present study investigated the most common diagnoses, diagnostic evaluation methods, and treatment protocols associated with water polo-related injuries in pediatric and adolescent athletes. Among our cohort of 56 patients, the most common site of injuries was the upper extremity (31 patients), followed by the lower extremity (13 patients), and the head (11 patients).

The most common upper extremity diagnoses made among these young athletes were rotator cuff pathologies (8/31 patients), shoulder instability (6), and scapular pathologies (6) (Table 4). Patients with shoulder instability often presented following acute subluxation/dislocation events in which opponents pulled on or twisted the athletes' arm. Upper extremity injuries were most frequently aggravated by throwing and swimming. Wheeler et al. found that 74% of shoulder soreness was related to throwing volume during Australian national team selection camp [17]. The repetitive overhead stress inherent to swimming has also been frequently linked to over use-related shoulder injuries such as rotator cuff pathologies and impingement [18-20]. In addition, player strength and flexibility as well as differences in scapular alignment have been investigated as potential risk factors for injury [3]. Among the patients analyzed in the present study, upper extremity injuries were evenly distributed between acute and chronic pathologies (15 acute and 16 chronic injuries) (Table 3). Diagnostic evaluation most often consisted of a history and physical exam with X-ray imaging (12 patients). An MRI was frequently indicated for these patients as well (8 patients). Only five patients did not receive any form of imaging.

Thirteen patients presented with lower extremity concerns (23.2%). Nine of these patients listed egg-beater kicking as contributing to their pain, and lower extremity injuries were most often chronic in nature (10/13 patients). The most common injuries included femoroacetabular impingement syndrome (FAIS), hip labral pathology, patellofemoral dysfunction, and patellar instability (Table 4). Langner et al. studied collegiate water polo players and synchronized swimmers with hip pain and found that FAIS

(27/40 hips) and labral tears (22/40 hips) were very common in these athletes [21]. The authors hypothesized that the anatomic impingement was related to treading water which is accomplished using the egg-beater kicking motion. As such, our findings that FAIS and labral pathology in the hip are common diagnoses made in young water polo players and that egg-beater kicking is frequently described as contributing to discomfort support prior research. Patelofemoral pain has been linked to both breast stroke kicking and egg-beater kicking [11,22]. This common diagnosis is frequently linked to overuse injuries as well which is consistent with our finding that the majority of lower extremity injuries among water polo players are chronic in nature [23]. The most common diagnostic work up plans included a history and physical examination with X-ray studies with or without MRI (6 patients each) (Table 5).

Concussion was the single most common diagnosis among our cohort of athletes (11 of 56 patients) (Table 4). The relatively large proportion of patients presenting with acute head trauma is consistent with prior research indicating that head injuries are among the most common for water polo players [4-7]. This is likely due in large part to the minimal protective gear worn by water polo players to protect their heads. The grappling that takes place in order to win possession of the ball and the ball being thrown at high velocities likely contribute to the high rate of concussions in the sport. Head imaging was rarely indicated for these patients with only one athlete receiving a CT scan. Instead, providers opted for a number of concussion assessment tools to evaluate patients including the Sport Concussion Assessment Tool 5th Edition (SCAT5) and ImpACT tests (Table 5). Medical management for these patients consistently included both physical and cognitive rest (Table 6).

For upper and lower extremity injuries, the most common treatment plans included physical therapy, rest from sports, and NSAIDs (Table 6). Future studies should seek to evaluate the efficacy of these protocols individually and in combination with one another. Due to the limited data on patient follow-up, we are unable to comment on the efficacy of these approaches. Surgical intervention was infrequently performed in our cohort of patients (6 of 56 patients). Future research should seek to understand the most common water polo-associated injuries for which surgical treatment is indicated.

Limitations

The methodology of the present study relied upon physician notes for data extraction. It is possible that physicians did not chart each mention by the patient of aggravating factors for their injuries. In addition, providers may have given verbal recommendations such as icing the affected joint at night or taking pain medications which they then did not include in the visit note. As such, it is possible that data on aggravating factors and treatment recommendations specifically are underreported. In addition, because we limited our search to patients who sought care with orthopedic surgeons or sports medicine physicians, it is possible that we therefore missed athletes who visited primary care physicians or neurologists (for concussions) to discuss water polo-related injuries. We may have similarly not included patients with water polo-

associated injuries in which their notes did not mention the phrase "water polo."

Given the retrospective design of the present study we are unable to make firm conclusions about the potentially causal relationship between patient injuries and associated aggravating factors. Likewise, we cannot comment on the efficacy of the treatment strategies recommended by providers as many patients did not follow up with their physicians. For this reason, we are similarly unable to describe the most common return to play timelines for patients. Future work may longitudinally evaluate young athletes' responses to various commonly recommended treatment modalities.

Conclusions

Providers should be aware of the spectrum of injuries that may result from playing water polo. It is important for physicians to inquire about the time course of injury as well as aggravating factors for pain as this may help to inform clinical decision-making. Surgical treatment is uncommonly required for water polo players in the pediatric and adolescent patient populations, so interventions such as physical therapy, rest from sports, and NSAIDs should be considered first line therapy in most cases.

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The authors report no conflict of interest.

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