

Hip Adductor Injury in Competitive Swimmers

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Methods: The authors conducted a survey of 296 competitive swimmers to assess the incidence and importance of interfering groin pain in breaststroke swimmers.

Results: Breaststroke swimmers were more likely to have current groin pain (6.92%) than individual medley swimmers who did not compete in pure breaststroke events (0, $P = 0.015$). Breaststroke swimmers (42.7%) were also more likely than individual medley swimmers (21.5%, $P = 0.000622$) or nonbreaststroke, nonindividual medley swimmers (5.8%, $P = 0.00000311$) to have been unable to train breaststroke in practice during the past year due to groin injury.

Conclusion: Results indicate that breaststroke swimmers are at significant risk of groin injury, groin injury is positively correlated with increased magnitude of breaststroke training, and groin injury may prevent participation in practices and competitions.

Keywords: hip adductor injury; adductor strain; competitive swimmer; overuse syndrome

Competitive swimmers typically train between 10,000 and 20,000 meters per day. Furthermore, swimmers generally compete in 10 or more minor competitions per year in which they swim a broad variety of events and 1 or 2 major competitions per year in which they swim their best competitive events. Several musculoskeletal injuries related to this repetitive motion have been documented.^{3,5,9,13,15}

Breaststroke swimmers put extensive stress on the hip adductor muscles during training and competition due to repetitive adduction.^{4,10} This stress occurs primarily during the powerful finish of the kick, when forceful adduction of the hips occurs with the knees in a flexed, valgus position with the ankles and feet externally rotated.¹⁰ Keskinen et al.⁴ found that peak adduction velocity of the thigh in breaststroke swimmers averaged 245° per second. This movement puts significant stress on the adductor longus, brevis and magnus, pectineus, and gracilis, and repetition of this movement hundreds of times per day may predispose breaststroke swimmers to overuse injury.

We hypothesized that breaststroke swimmers are at increased risk of hip adductor injury and that this injury pattern has an impact on swimmers who train and compete in breaststroke. The primary purpose of this study was to determine if breaststroke swimmers are at increased risk for hip adductor pain and resultant missed

training when compared to swimmers of other competitive strokes. The secondary purpose was to determine whether individual medley swimmers, who generally train an intermediate amount of breaststroke between that of a nonbreaststroke swimmer and that of a breaststroke swimmer, have an intermediate level of hip adductor injury that correlates with an intermediate level of training.

MATERIALS AND METHODS

Study Population

Teams selected for contact had finished among the top 25 in the 2000 National Collegiate Athletic Association (NCAA) Division I Championships. Eight men's, three women's, and six coed teams participated. The director of the National Select Camp also agreed to invite the 39 camp members to participate in the study. National Select Camp participants are predominantly junior to senior national-level high school-aged swimmers.

We sent to the coaches the number of surveys equal to the number of swimmers on the team, along with a self-addressed, stamped envelope to return all surveys. In a cover letter that accompanied the package, we encouraged coaches to ensure that every swimmer on their team was offered a survey and asked them to distribute the forms during a team meeting so that swimmers would be more likely to complete the survey. Coaches were asked to assure participants that their data would remain anonymous. We included enough pencils in the package for the entire team to complete the forms on the pool deck.

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Each two-page survey had a consent form stapled to the front that was to be signed and returned with the survey by the swimmer or by a legal guardian if the swimmer was a minor. A copy of the consent form was included for the swimmer to keep. Of the 341 surveys distributed, 296 (87%) were completed and returned. We made follow-up telephone calls to coaches who did not return the surveys within 4 weeks. Four surveys that had been partially completed were not included in the study.

The Survey

The survey asked for age, gender, age of entry into swimming, age of entry into competition in breaststroke or individual medley (individual medley swimmers race equal distances of each of the four strokes), and highest competitive level in breaststroke events. Cross-training was assessed by asking how many minutes per week the subject spent lifting leg weights or doing stretching exercises for hip adductors. Subjects were also asked to provide details about their training, including their weekly distance of breaststroke swimming and kicking. Breaststroke kicking is commonly performed with a kickboard, which preferentially exercises the lower extremities.

Subjects were asked the number and average duration (in days) of episodes of hip adductor pain or subjective weakness, how many times the injury(ies) had prevented breaststroke kicking or swimming in practice, and at what period during the swimming season the injury(ies) occurred. Subjects were asked whether they had sought help from a physical therapist, physician, or chiropractor, or had any imaging study for hip adductor injury. Treatment regimens for hip adductor injury were assessed by asking how many minutes per week the subject spent receiving electrical stimulation, ultrasound, ice, or massage to the adductor group. Subjects were asked to name any medicines they took specifically for hip adductor pain. Space was available on the survey for the subject to write further comments or clarifications.

We conferred with the Stanford Statistical Consulting Service in survey design and again during analysis of the data. Power analysis determined that 68 athletes per group were required to show significant differences with $P = 0.05$, based on expected differences between groups. We used the chi-square test to compare frequencies between groups in all statistical calculations except those otherwise noted. The chi-square results were modified with the Bonferroni correction, which is a conservative method to correct for multiple comparisons. All statistical tests were run using Microsoft Excel.

We received no funds from any commercial source, and the Institutional Review Board at Stanford University approved the research protocol for this study.

RESULTS

Table 1 lists the demographics and training patterns of study participants. Subjects were split into three groups on the basis of their participation in breaststroke and/or

individual medley in their end of season competition: 130 breaststroke swimmers, which included some swimmers who competed in individual medley as well as breaststroke events; 80 individual medley swimmers who did not compete in pure breaststroke events; and 86 swimmers who competed in neither individual medley nor breaststroke. The groups were not statistically different in terms of age, gender, or years in competitive swimming, except that there was a significantly higher percentage of men in the nonbreaststroke, nonindividual medley group (76.7%) than in the individual medley group (58.8%, $P < 0.025$). Breaststroke swimmers trained more meters of breaststroke per week than individual medley swimmers who did not compete in pure breaststroke events, and both groups trained more breaststroke than nonbreaststroke, nonindividual medley swimmers.

Breaststroke swimmers were more likely to have current hip adductor pain (6.92%) than individual medley swimmers who did not compete in pure breaststroke events (0, $P = 0.015$) or swimmers who did not compete in breaststroke or individual medley (0, $P = 0.015$). A significantly higher percentage of breaststroke swimmers (42.7%) than individual medley swimmers (21.5%, $P = 0.00062$) or nonbreaststroke, nonindividual medley swimmers (5.8%, $P = 0.0000031$) had been unable to swim or kick breaststroke in practice during the past year due to hip adductor injury (Fig. 1). Individual medley swimmers also had missed significantly more practices due to hip adductor injury than nonbreaststroke, nonindividual medley swimmers ($P = 0.00061$). There was no significant gender difference in incidence of groin pain or missed practices.

Of swimmers who had missed practices in their swimming careers due to hip adductor injury, breaststroke swimmers had missed an average of 11.5 practices, individual medley swimmers an average of 12.4 practices, and nonbreaststroke, nonindividual medley swimmers an average of 6.9 practices. Of swimmers who had experienced hip adductor injuries, most had been injured in the early season (58.1%) or midseason (72.1%) rather than in the late season (21.3%).

Of breaststroke swimmers, 9.2% had missed a competition due to hip adductor injury, compared to 6.3% of individual medley swimmers and zero nonbreaststroke, nonindividual medley swimmers, but these data did not reach statistical significance (breaststroke swimmers versus individual medley swimmers: $P = 0.0788$; breaststroke swimmers versus nonbreaststroke, nonindividual medley swimmers: $P = 0.0641$; individual medley swimmers versus nonbreaststroke, nonindividual medley swimmers: $P = 0.291$). Breaststroke swimmers who had missed competitions had missed an average of 2.2, and individual medley swimmers had missed an average of 2.6. There was a non-significant trend toward more missed major competitions in breaststroke swimmers (3.8%) versus individual medley swimmers (2.5%).

Breaststroke swimmers (18%) were more likely to believe that they had been adversely affected by hip adductor injury in competition when they were able to compete than were individual medley swimmers (9%, $P =$

TABLE 1
Demographics and Training Patterns

	Breaststroke swimmers	Individual medley swimmers who do not compete in pure breaststroke events	Nonbreaststroke, nonindividual medley swimmers
<i>n</i>	130	80	86
Men	85 (65.4%)	47 (58.8%)	66 (76.7%)
Age (mean ± SD)	19.0 ± 2.0	19.2 ± 2.4	19.8 ± 2.0
Years competitive swimming ± SD	10.5 ± 3.5	11.6 ± 2.9	11.0 ± 3.5
Years competing in breaststroke ± SD	8.3 ± 3.8	0	0
Meters per week breaststroke swim ± SD	9017 ± 7162	5853 ± 1961	436 ± 694
Meters per week breaststroke kick ± SD	4072 ± 7108	2539 ± 1948	165 ± 391

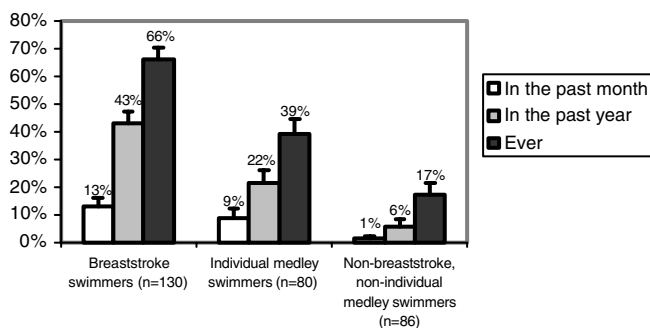


Figure 1. Incidence of missed practice due to groin injury (\pm standard error of the proportion).

0.00146) or nonbreaststroke, nonindividual medley swimmers (0%, $P = 0.000986$). Individual medley swimmers were more likely to believe that they had been adversely affected by hip adductor injury in competition than were nonbreaststroke, nonindividual medley swimmers ($P = 0.0204$).

Within each of the three end-of-season event groups, men and women were equally likely to have experienced hip adductor pain or to have been unable to compete in breaststroke training due to hip adductor injury. When controlled for distance of breaststroke training, precollegiate (aged 13 to 18), collegiate (18 to 21), and postcollegiate (22 to 27) breaststroke swimmers were all equally likely to have missed practices in the past year due to hip adductor pain.

Swimmers who had missed practice due to hip adductor injury were more likely to have consulted a physical therapist (15% versus 3%, $P = 0.000117$), a physician (9% versus 2%, $P = 0.00104$), or a chiropractor (5% versus 0%, $P = 0.00389$) than those who had not. Swimmers who had missed practice due to hip adductor injury were also more likely to have used ice on the area (12.0% versus 0.0054%, $P = 0.0000188$). The majority (77.36%) of subjects performed adductor-stretching exercises on a regular basis, and we found no difference in stretching between those who missed practice due to a hip adductor injury and those who did not miss practice. Frequency of the use of massage (4.50% versus 2.16%), electrical stimulation (2.70% versus

0%), and ultrasound (0.90% versus 0.005%) to the hip adductor were not significantly different between those who had missed practice due to hip adductor injury and those who had not. Nonsteroidal anti-inflammatory drugs were used by 3.60% of swimmers who had missed practice due to hip adductor injury and 0.0054% of those who had not.

DISCUSSION

Swimming is included in a list of sports associated with hip adductor injury, as reported by Meyers et al.⁶ Rodeo¹⁰ quoted an unpublished study of two NCAA division I swimming teams, which found that 10 out of 30 breaststroke and individual medley swimmers had experienced strain injury to the hip adductor and flexors. There is one published case study of adductor tendonitis in a female breaststroke swimmer,¹⁵ although the article is focused on her individual treatment and does not discuss incidence of this problem in breaststroke swimmers as a population.

In our study, 42.7% of respondents who compete in breaststroke have been unable to participate in breaststroke training in practice at some point in the past year due to hip adductor injury. Even short periods of no training have been shown to significantly reduce muscular strength and endurance in competitive swimmers.⁷ We believe that this justifies concern that hip adductor injury may adversely affect the ability of swimmers to train and compete. However, swimmers at higher levels in the sport tend to have experienced more episodes of hip adductor injury. This suggests that breaststroke swimmers accumulate injuries with increased competition and that some swimmers reach a high competitive level despite recurrent hip adductor injury.

Hip adductor injury can cause not only pain but also the sensation of weakness, which limits or prevents participation in training. Some comments written at the end of the survey suggest that the sensation of hip adductor weakness or a "twinge" is a warning sign for imminent, more serious injury if the activity continues. However, in some athletes, the pain that follows the initial injury may actually be relieved by continued activity, which may lead to

further injury.⁸ With education, it may be possible for athletes to learn to recognize this sensation and identify impending hip adductor injury earlier, preventing missed practices and competitions.

Our results show that hip adductor injury is correlated with increased distance of breaststroke training. The remarks of the swimmers on the timing of their injuries converge on early to midseason as the time when these injuries are most likely to occur: "My groin gets irritated only when I haven't kicked breaststroke for a while and then I start back up—usually early season."

Our study has several potential sources of bias. First, 13% of swimmers who were offered a survey did not complete and return it. Participation was optional; thus, swimmers who had experienced hip adductor injuries may have been more likely to complete surveys. We attempted to minimize this effect by keeping the survey short and providing all necessary materials. It is also possible that the survey underestimated the frequency of hip adductor injury, as the most severely injured athletes may not have been in attendance at practice due to the injury. We know of one elite breaststroke swimmer who was forced to "red-shirt" due to a severe hip adductor injury and was therefore not present to complete the survey.

Second, the surveys were primarily sent to the coaches in December, but they were returned throughout winter and spring. Most swimmers have a similar training cycle of long-distance training in the fall and winter and shorter speed-oriented workouts in the spring and summer, although this is variable. This variability could result in injuries occurring more frequently at different times of the season for different athletes. Our study showed that swimmers are more likely to experience hip adductor injury in the early to midseason. Thus, swimmers who completed the survey in the late season may have been less likely to report current hip adductor pain.

Finally, team selection was not done at random. Due to the involved nature of a coach's participation in this project, we felt that the survey return rate would be higher and our instructions would be followed more closely if we chose coaches that one author (KG) knew personally. We think the effect of this bias was minimal, as most coaches train a broad range of swimmers for every competitive event.

It is important to consider non-sport-related causes of groin pain in athletes. The differential diagnosis for groin pain should include appendicitis, Crohn's disease, nephrolithiasis, inguinal hernia, prostatitis, pelvic inflammatory disease, menstrual cramps, and ovarian cysts.¹⁴

Research on hip adductor injury in sports other than swimming suggests that certain techniques may be useful for preventing injury in swimmers. Several swimmers' comments indicated that they believed stretching could help prevent hip adductor injury: "Groin pain was more frequent in high school. Now that I am in college we do enough stretching so that I rarely strain or pull my groin." "General stretching played a large part in my overcoming groin stress." However, a recent review by Shrier¹² suggested that there is little evidence that stretching before exercise can protect against injury.

Studies of sports other than swimming suggest that warm-up of the musculature of the thigh may be the most important step in preventing injury.¹¹ Ekstrand and colleagues demonstrated a 75% lower incidence of hip adductor injury in a randomly selected soccer team that used a stretching regimen and supervised warm-up and confirmed this finding in a second study.^{1,2} These studies suggest that it may be possible to develop a warm-up regime to reduce the incidence of hip adductor injury in swimmers.

Hip adductor injury in breaststroke swimmers may result from a different mechanism than in sports such as soccer and ice hockey where the injuries are well studied. Whereas in soccer and ice hockey hip adductor injury occurs as a result of forced adduction, or adduction against a stationary object (the ground or ball), in breaststroke swimming the injury may either result from microtrauma due to repetitive adduction or from the high stress of a single forceful adduction against the water mass. This difference may justify a different approach to prevention and treatment. Prospective study is needed to define the best preventive and treatment regimens for competitive swimmers.

Technique changes may also be helpful in preventing injury. A wider breaststroke kick, which Stulberg et al. demonstrated leads to more frequent "breaststroke knee,"¹³ might also put more strain on hip adductors, predisposing them to injury. A narrower kick shifts stress from hip adductors to extensors of the knee and has been proposed by some coaches as an approach to reduce the incidence of hip adductor injury. Some swimmers in the survey recognized this: "I only hurt if I kick the wrong way, with my knees far apart."

In summary, our results show that hip adductor injury is a common problem among breaststroke swimmers and is related to level of training and participation. Future studies need to address which hip adductor (adductor longus, brevis, pectineus, magnus) is involved and where in the muscle-tendon-bone unit the injury most commonly occurs.

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