

THE RELATIONSHIP OF BREASTSTROKE TRAINING ON KNEE PAIN AND Q ANGLE OF BREASTSTROKE AND CRAWL SWIMMERS

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Abstract. Competitive swimmers have a high incidence of breaststroke-related knee injuries. The cause of the breaststroke swimmer's knee, which is accompanied with medial pain of the knee joint, has not been clearly identified. The purpose of this investigation was to determine the biomechanical and anatomical factors which predispose subjects to injury. This study includes 60 breaststroke and crawl swimmers (16 ±3.2 years old) who have participated in 3–6-year-long swimming training in Tabriz city. The knee pain was evaluated with McGill's pain questionnaire, and Q angle was measured with universal goniometry by knee radiography in standing position. The medial pain of knee joint increased significantly and the knee was only symptomatic when the swimmers performed the whip kick. Breaststroke swimmers were hardly able to complete training because of the knee pain. It is concluded that competitive training of breaststroke swimming for 6 months can cause exclusive injury and pain in swimmer's knee. On the other hand, the result showed that there is a direct relationship between the swimmer's Q angle amount and chance of the knee injury. This emphasizes a serious consideration of Q angle states in breaststroke swimmers.

Key words: Q angle, whip kick, universal goniometry

Introduction

Swimming is an ideal form of sport without any athletic injuries. Although it seems that physical injuries and problems are just appearing as a result of competitive and severe trainings on ground, it has been shown that frequent, excessive and small wounds in swimming result in injuries such as swimmers' shoulders and breaststrokers' knee. These two terms describe different types of injuries which occur in shoulders and knees of swimmers because of frequent and harsh nature of competitive swimming training (Bak et al.1998; Kawalek and Garszka 2013). The most prevalent pain (after shoulder pain) among swimmers, especially in breaststroke swimmers, is knee pain (Costill

1992). After investigating different parts of muscular skeletal system, it was found that most of swimmers are suffering from pain in internal parts of knees (Waryasz and McDermott 2008). This problem, which is known as breaststroke swimmers' knee, was shown in Vizsolyi et al. (1987) study on 391 competitive swimmers in 56 of 77 breaststroke swimmers (73%). Moreover, they reported this problem in 153 of 314 swimmers of other disciplines (47%) (Pollard et al. 2008). Pollard et al. (2008) reported 5 times higher prevalence of knee pain among breaststroke swimmers of 200 and 400 meter than other fields of swimming (5). It is said that breaststroke swimming, especially in 200 and 400 meters, can increase probability of knee injuries more than other types of swimming (Johnson et al. 1987); and a professional breaststroke swimmer may withdraw after 2–3 years as a result of pain in the internal part of knee (Waryasz and McDermott 2008; Johnson 2003; Kenal and Knapp 1996; Kennedy and Hawkins 1974; Keskinen et al. 1980; Schmitt et al. 2008; Peter 1985). Prior studies had reported any type of abnormality in breaststroke swimmers knee (Knobloch et al. 2008) and they have just shown that the knee of breaststroke swimmers are stricken in synovial membrane inflammation. From the time of recognizing effect of mechanical factors in creating knee pain of breaststroke taking techniques are used in biomechanical analysis swimmers, photo and precise recognition of cause of knee pain in swimmers. Recently it is claimed that whip kick technique as a main factor of causing pain (Pollard et al. 2008; Grote et al. 2004) enters more adduction pressure on knee joints and causes internal hip and external tibia to rotate. Frequent and intense performance of this technique poses tension to soft tissues of internal knee joints in a way that which results in instability of internal part of joint, pain and inflammation (Knobloch et al. 2008; Schmitt et al. 2008; Livingstone and Spaulding 2002; McMaster 1996). In spite of emphasis of studies' on this note that breaststroke swimming technique may cause tension in ligament of internal knee, and instability of knee inside, it is proved that in consequence of this pressure we will observe knee mechanical imbalance in the direction of ankle toward outside and rotating knee in this direction (Pollard et al. 2008; Nguyen et al. 2009; Rodeo 1999). Reviewing of breaststroke swimmers result shows that knees of these swimmers face mechanical changes in addition to inflammation and pain. According to results of these studies knee pain and mechanical imbalance of knee joint is the most prevalent problem among breaststroke swimmers (Costill 1992; Knobloch et al. 2008; Rovere and Nichols 1985; Lin et al. 2008). Studying of Q angle is one of the main tools of evaluation mechanical condition of athletes' knee joint. If this angle is not normal, so the probability of injury in athletes' knee joint when performing sportive activities will be increased. If this angle is more than natural it causes knee mechanical imbalance and in this situation tissues of internal parts of knee joint are faced with injuries. The normal size of Q angle in straight manner for male teenagers is 12.2 ± 2.2 (McMaster 1996; Schultz 2006). Livingstone and Spaulding (2002) and showed that three main factors of external rotation of tibia, ankle deviation and internal rotation of hip causes Q angle of knee to increase. In fact when breaststroke swimming technique is performing all of these items happen in knee joint of swimmer and according to this, questions like: "do breaststroke swimming trainings cause intensive pain in knee of swimmers through passing of time" arise. Do breaststroke trainings have the same amount of pain to crawl swimmers as to breaststroke swimmers? Do breaststroke trainings increase Q angle of swimmers drastically in long time? Does Q angle size of breaststroke swimmers affects the probability of internal knee part injuries? Present study while investigating above mentioned items specially 3 final questions (though fewer studies have been done in this area) tries to answer them. Regarding to the necessity of paying serious attention to mechanical condition of breaststroke swimmers' knee joint and also considering relationship with probability of swimmers knee injuries, the present study investigated effect of 6 months of breaststroke swimming training on crawl and breaststroke swimmers' knee pain and their Q angle size. More over this investigation have studied effects of Q angle size on

probability of knee injuries for breaststroke and crawl swimmers. Statistical methods: Referring to Tabriz Shand swimming pool and with aids of Tabriz province swimming team mentor 20 swimmers of breaststroke and 20 crawl swimmers were selected randomly. All subjects were training under investigation of mentioned mentor. Average age of swimmers was 16 and all of them had participated at least 3 and at the most 6 years in province swimming team training programs. Among each group of swimmers 10 swimmers were selected as subject group and 10 of them were selected as control group. Performing training was continued 6 months under investigation of coach and researcher. These training were including breaststroke swimming, emphasizing on whip kick technique intensity of 60–80 percent of the maximum ability of swimmers. Training course was 3 sessions in a week each session holding 1 hour. Controlling group swimmers did not performed any kind of training during this course. We assessed swimmers' knee pain through a questioner before starting training. Moreover their Q angle was measured by a ruler and goniometer using radio graphical photos of swimmers' back hip in right position. In order to measure Q angle first of all we determined place of node of prickle of back hip, middle of kneecap, and node of raw bone. After that determining points were connected to each other by ruler and continued till angle produced by continuation of two lines connecting prickle of hip back bone to central point of kneecap bone and using a goniometer the connecting line of raw bone node to central point of kneecap registered as Q angle. McGill questioner was completed by swimmers during 6 months training course once every 2 months to assess their pain. This questioner was designed by doctor Melzack in McGill university of Montreal (Canada) which can be used to determine degree of pain and its changes through time passing. Questions of this questioner were divided into 3 parts: 1-howness of pain felt, 2-pain change through time passing and intensity of pain felt. Minimum point of this questioner is 0 and the maximum point is 78. High point shows more pain (Melzack 1975; Stein and Mendl 1988).

In this study all of the measurements were done investigator and one assistant was just registering them. In order to compare the average points of pain questioner we used dependent group T-test for both control and experimental groups of swimmers. More over we used independent T-test to compare points of between classes of two groups. Also we used independent groups T-test to compare average differences of pre-test and post-test of groups. Data from measuring Q angle of swimmers were compared before and after performance of training with each other. Knee pain points of swimmers whose natural size of Q angle was higher than healthy people, were identified and compared with points of swimmers whose Q angle was natural during performing training. Normal distribution of data was measured by Kolmogorov-smirnov test and homogeneity of variances was assessed by Luann test.

Results

Results of investigation of knee pain of swimmers each 2 months during a 6 months course can be seen in Table 1.

As it is showed subjects' knee pain during training course through time passing has been increased and this increase in breaststroke swimmers was more than crawl swimmers. Considering points of crawl subjects' pain questioner showed that knee pain of these swimmers increased in accordance with increase in time duration of training, but this increase was slowly in a way that after passing 4 months of training although knee pain of these swimmers increased, this increase in contrast to degree of pain before starting training had insignificant difference ($p = 0.12$). In spite of this when crawl swimmers training reached at 6 months, pain of internal parts of knee in comparison with knee pain before starting training increased significantly ($p = 0.02$). Although before training

start knee pain point of breaststroke swimmers had significant difference with crawl swimmers ($p = 0.13$), rapid progress of pain appears in former such that pain point of these swimmers in 2nd month in contrast to time of before starting of training has significant increase($p = 0.001$)and this increase continued in coming months so that most of breaststroke swimmers could complete the course difficultly. In 4th month the pain degree of breaststroke swimmers was significantly more than crawl swimmers ($p = 0.01$) and this significant difference appears in 6th month also ($p = 0.001$). Average knee pain of swimmers of 2 control group during this study had no significant change ($p = 0.76$).

Table 1. Average of knee pain rate of swimmers during training time

	Before studying	After 2 months	After 4 months	After 6 months
Breaststroke subjects	11	16	25	49
Crawl subjects	7	10	18	32
Controlling group of breaststroke	10	11	10	9
Controlling group of crawl	9	9	8	10

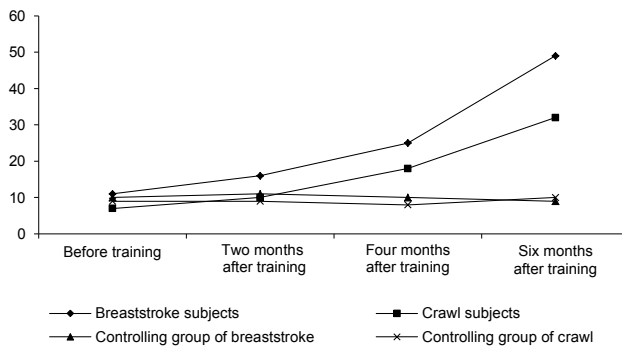


Figure 1. Comparing increasing rate of knee pain, between two groups of experimental and control

Average Q angle of swimmers during 6 months of training has been presented in Table 2.

Table 2. Average of Q angle before and after training

	Before	After	Experimental t	Meaningful area
Experimental breaststroke	16.7	16.9	1.04	0.213
Experimental crawl	15.2	15.0	0.21	1.354
Controlling group of breaststroke	15.4	15.3	0.09	2.011
Controlling group of crawl	15.0	15.2	0.23	11.98

Although the average Q angle size of knees of crawl and breaststroke swimmers increased, calculation results showed that this increase was not significant statistically ($p = 0.073$).

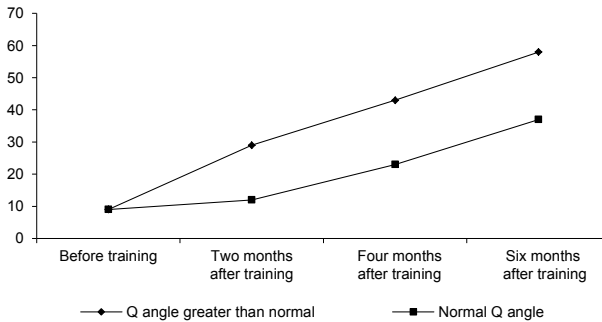


Figure 2. Increasing rate of knee pain between swimmers with higher Q angle than normal and swimmers with normal Q angle

Considering knee pain of swimmers showed that knee pain of all swimmers before starting training was not different statistically ($p = 0.24$), but after start of training knee pain specially in breaststroke swimmers increased and after two months, their pain increased meaningfully, in comparison with, before starting of training ($p = 0.001$). Knee pain of crawl swimmers after 4 months of starting of training increased significantly ($p = 0.03$) and this increase repeated in 6th month for both groups. Comparing knee pain of four groups in 1st, 4th and 6th months with their points before starting training showed that increase of knee pain in breaststroke swimmers was developing faster in comparison with crawl swimmers. Also knee pain point of breaststroke swimmers in 2nd and 6th months was significantly ($p = 0.01$) higher than knee pain point of crawl swimmers (Figure 3).

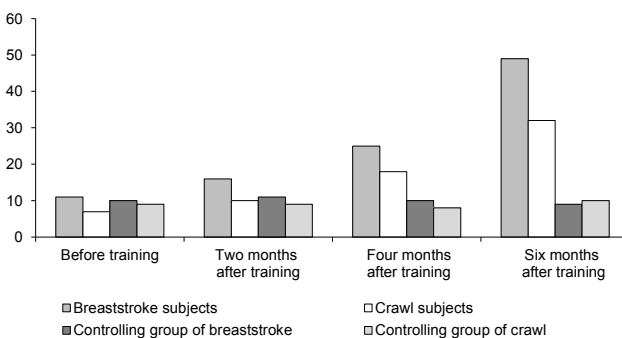


Figure 3. Knee pain increasing of swimmers in 6 months

Considering pre-test point difference of pain in 2nd and 6th months for both groups and comparing them claims that during first 2 months and also during whole 6 month course, in spite of knee pain in both groups degree of knee

pain in breaststroke swimmers was significantly higher than crawl swimmers ($p < 0.001$). Table 3 shows statistical comparison of pre test and post test pain differences in both groups.

Table 3. Comparing differences of pain rate before test and in second and sixth months

	Before test and 2nd month	Before test and sixth month
Experimental breaststroke	7	38
Experimental crawl	3	24
Experimental t	2.012	1.541
Meaningful area	0.00	0.01

Conclusion and Discussion

It is claimed that knee pain of swimmers is an overuse syndrome and competitive breaststroke swimming training poses pressure on knee joint of swimmers through pass of time and finally causes pain in internal knee. Comparing increasing procedure of degree of pain among breaststroke and crawl swimmers during 6 months of competitive training showed that knees of breaststroke swimmers in comparison to crawl swimmers are more vulnerable to injuries, and only after two months of training knees of breaststroke swimmers faced with pain in internal parts. As mechanical imbalance of knee and its instability is one of the main causes of knee joint injuries during performing sportive activities (Pollard et al. 2008), it is probable that breaststroke swimmers' knees have less mechanical balance in comparison to crawl swimmers knees and this instability may have appeared during long term breaststroke swimming training. Kaskenin et al. (1980) and Rovere and Nichols (1985) have pointed to relationship between breaststroke swimming and pain of internal parts of knee of swimmers. Generally in this study we concluded that increase in distance and increase in intensity of breaststroke swimming training increases the chance of injuries in swimmers and the main cause of pain is whip kick technique. Biomechanical analysis of swimmers' knee joint during performing whip kick technique which has been done by other researchers like: Vizsolyi et al. (1987), Stulberg et al. (1980) has shown that while performing whip kick technique, swimmers' knee joint causes raw bone rotation in vertical plate. This can impose maximum pressure on knee joint (Omolulu et al. 2008), diverts ankle in frontal plate to outward side of body and in the same time hip is predisposed internal rotation and performing this activity in long term and intensively through pass of the time causes tension in internal tissues of knee joint, pain in internal parts of knee and probably mechanical changes in knee joint. Kennedy and Howkins (Waryasz and McDermott 2008) believe that knee of breaststroke swimmers is created as a result of weak inside internal ligament which is resulted from frequent tension during swimming. They believe that these tensions in extension part of foot kick along with excessive pressure of valgus on knee joint are appeared in final stage of foot kick. The exerted pressure on side internal ligament which is the main supportive structure of internal knee and is also called raw bone, during knee activity from flexion mode to extension mode, increases and this is the same thing that happens during foot kick of breaststroke swimming (Waryasz and McDermott 2008).

Results of knee Q angle measurement of swimmers before and after 6-month training course show that: although performing competitive trainings of breaststroke swimming causes knee pain both in crawl and breaststroke swimmers, during this course no significant change observed in Q angle size of swimmers. This

inflexibility of Q angle size might be observed due to short time duration of research in which the significant biomechanical changes were expected and it might be that if the duration of study was longer Q angle of swimmers would be affected by trainings. It has been shown that if Q angle of runner athletes be wider, they might experience internal knee pain. These results have been reported by other researchers for athletes of other fields. We compared increasing procedure of pain for those subjects whose Q angle was higher than natural position ($Q > 16$) with those whose Q angle was natural in order to determine differences of knee vulnerability of these athletes and it was concluded that increasing knee pain in swimmers of more than normal Q angle size is faster than those of normal Q angle size such that knee pain points of swimmers with Q angle of higher than normal size in 2nd, 4th and 6th months was significantly more than those of normal Q angle size. From these results we can predict that Q angle size for swimmers was a determining factor in degree of knee vulnerability when performing breaststroke swimming. Nevertheless considering Q angle size of swimmers as an effective factor in probability of vulnerability should not be ignored.

Generally speaking it was concluded that in order to avoid knee pain of breaststroke swimmers, the time of competitive training courses should be short linked with rest. It is recommended that this rest time be less than 2 months. Although 6 months of breaststroke swimming did not change Q angle of swimmers, taking into consideration the increasing procedures of intensive knee pain in swimmers of more than normal size Q angle rather than swimmers of normal Q angle size we can avoid knee injuries of professional breaststroke swimmers by pre assessing the Q angle size of swimmers and providing swimmers of more than normal Q angle size with corrective trainings and also by correcting breaststroke swimming technique in order to decrease internal rotation of knee joints and by doing so we can guarantee perpetual presence of these athletes in competition fields.

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