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Isokinetic Parameters of Shoulder Joint in Tennis Elbow Versus Golfr's Elbow

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Abstract : Purposes: The aim of our study is to analyze the difference between normal subjects and patients with elbow problems (tennis elbow or golfer's elbow) in shoulder isokinetic parameters. **Material and Methods:** Thirty male athletes participated in our study and divided into equally three groups. The first group (A) suffered from tennis elbow, the second group (B) suffered from golfer elbow, and the third group (C) is normal subjects. Each of them consisted of ten participants. Their age ranged from 20 - 35 years. Open kinetic chain shoulder flexion and extension peak torque were measured at angular velocity (60º/sec) with concentric/eccentric mode by Biodex System 3 Multi-Joint system testing and rehabilitation (Biodex Medical system, Shirley, NY, USA). **Results:** The statistical analysis revealed that there was no significant differences in the mean values of the "eccentric peak torque of shoulder flexors" among three groups with (P>0.05). While, there was a significant difference in the mean values of the eccentric peak torque of shoulder extensors among three groups with (P<0.05). Multiple pairwise comparison tests revealed that there were no significant differences of eccentric peak torque of shoulder extensors between (Group A Vs. group B) and (Group A Vs. group C) with (p=>0.05) and there was a significant difference of eccentric peak torque of shoulder extensors between (Group B Vs. group C). **Conclusions**: It can be concluded that there is no difference in the shoulder flexors' peak torque between athletic patients suffered from tennis elbow, golfer's elbow and normal subjects, but there is a difference in shoulder extensors' peak torque between athletic patients suffered from golfer's elbow, and normal subjects. This was significant reduction in favor to group (B).
Key words : tennis elbow, golfer's elbow, isokinetic parameters, shoulder joint.

Introduction

Tennis elbow has been found to be the second most frequently diagnosed musculoskeletal disorder of the upper extremity in the primary health-care setting. "Golfer's elbow" is not that commonly encountered. It has been stated that tennis or golfer's elbow syndromes are self-limiting. Even so, clinical experience has shown that there are a few cases where symptoms have a painful and long-lasting course, resistant to many forms of therapy as reported by Svernl et al[1]. The most common problem in the shoulder is Subacromial impingement syndrome; the most common in the elbow is tennis elbow. Subacromial impingement syndrome and tennis elbow are common conditions found in the general population with reported prevalence rates of up to 10 and

3% respectively as reported by Struijs et al[2]. Moreover, it is not entirely uncommon for these two conditions to present concurrently as reported by Wainner et al [3].

Tennis elbow is caused by degeneration and tearing of the common extensor tendon, this condition is most often associated with overuse or a repetitive stress, as opposed to an acute inflammatory reaction as reported by Svernl et al [1]. This condition affects both genders, with an equal distribution between men and women and people aged between 30-50-years are most vulnerable. The dominant side of the body is more frequently affected. The dominant arm is involved in 75% of patients, suggesting that work-related forceful and repetitive wrist extension may have a role in the pathogenesis as reported by Nazar et al [4].

Golfer's elbow is considered to be the most common cause of medial elbow pain. Golfer's elbow, also known as medial epicondylitis or pitcher's elbow or medial epicondylagia is caused by degeneration of the common flexor tendon secondary to overload of the flexor- pronator muscle group that arise from the medial epicondyle as reported by Rineer and Ruch[5]. This injury is associated with gripping the club too tightly, which increases tensile load to the flexor of the wrist and fingers as reported by Wadsworth[6]. This process is associated with fibril degeneration of collagen and angiofibroblastic hyperplasia[7]. The term epicondylitis is considered by some to be a misnomer because there is no evidence of inflammatory cell infiltrates. Injuries to the medial epicondyle occurs common in the dominant elbow as a result of overuse as reported by Svernl et al [1].

The pathogenesis of the condition is not fully understood, although it has been proposed to be caused by chronic repetitive concentric and eccentric overuse of the flexor–pronator muscle group. This is suggested to result in micro tearing and progressive degeneration as a result of an immature repair response of the muscles as reported by Walz et al 7. The young active populations are also at risk for tennis elbow and Golfer's elbow. The incidence of tennis elbow and Golfer's elbow increased with increasing age in this population. Moreover a higher incidence of tennis elbow and golfer's elbow in whites compared to blacks as reported by Svernl et al [1].

Muscles and tendons need to have sufficient strength, flexibility, and endurance in order to withstand the forces unleashed during work or play without being injured. This same concept applies not only to the elbow itself, but to the entire "kinetic chain" that extends from the ground up from the legs, hips, trunk, spine, and shoulder through to the elbow, wrist, and hand. A "weak link" anywhere along the chain can affect another link where the problem may occur as reported by Miyashita et al [8].

The shoulder, elbow, and wrist each function as a link in the kinetic chain during upper extremity movements. The kinetic chain is the sequencing of individual body segments which are coordinated in their movements by muscle activity and body positions. This sequencing enables the body to generate, summate, and transfer force through these segments to the terminal component as reported by Van Der and Kibler [9]. The elbow depends on the more proximal links of the kinetic chain to generate this high force and the velocity. The scapula also plays an important role in upper extremity function. It acts as a stable base with which the humeral head articulates during shoulder motion and provides a foundation on which the several muscles of the shoulder insert or originate. The scapula must also move to function normally. It rotates upward to allow clearance of the humeral head under the acromion as the humerus elevates as reported by Oatis [10]. If the shoulder and scapula are not functioning correctly, the transmission of the large forces to the upper extremity is impaired.

Deficits in the kinetic chain proximally can lead to mechanical adaptations that may change the position of the elbow or cause local musculature to compensate as reported by Lucado et al [11]. Because the elbow is at the more distal end of the kinetic chain, it is subject to repetitive and high load forces with the motion, much like the end of a whip. If not well regulated proximally, the high load forces can create chronic stresses at the elbow and wrist and may cause injury at the origin of the wrist extensor musculature as reported by Kibler and Sciascia[12]. In 2007, Alizadehkhaiyat[13] found that a generalized weakness of the entire arm, including the shoulder abductors and rotators, is present in people who have tennis elbow. The mechanisms of joint and muscular imbalances that lead to functional impingement of the shoulder joint may impair the stabilization and power function of the shoulder resulting in over compensation of the wrist extensors during the motion. This may contribute to microtrauma at the soft tissue structures at the lateral epicondyle, thus causing symptoms of tennis elbow, although some advocate rehabilitation of upper extremity in the context of the kinetic chain as reported by Lucado et al [11].

There is little scientific literature that associates anatomic adaptations at the shoulder joint and surrounding musculature to faulty mechanics more distally at the elbow. Essentially in regards to the shoulder, compensatory strategies at the distal upper extremity due to changes at the shoulder may overload smaller muscles in the forearm which cannot safely handle the extra stress, especially under repetitive conditions.

There is no studies deal with tennis elbow and golfer's elbow through shoulder evaluation. There is no gold standard for treatment. This study may help seek appropriate assessment and treatment of tennis elbow and golfer's elbow in general population and athletes. Integration of this knowledge may then serve as a framework and key elements needed to guide the physical evaluation, the subsequent more effective treatment plan, and preventative measures for the person exhibiting symptoms of elbow problem. Identifying possible risk factors contributing to increase of the stress so that we will help to prevent elbow injury from occurring and recurrence.

The restoration of more normal arthrokinematic patterns and upper extremity strength along the entire upper extremity kinetic chain could be a valuable adjunct to existing treatment techniques and could possibly reduce the incidence of recurrence for these conditions. Physical therapists and occupational therapists will become experts in identifying and fixing behaviors that result in work related injuries**,** a fact that is beneficial for both the patients and therapists.

Material and methods

Subjects

Thirty male athletes with age between 20-35 years participated in the study. Group (A) consisted of 10 participants were complain from tennis elbow, group (B) consisted of 10 participants were complain from golfer's elbow, and group (C) is the control group which consisted of 10 normal subjects, who didn't have history of elbow problems. All participants provided written consent prior to participation in our study. Subjects with history of elbow fractures within the preceding 10 years, surgery and traumatic injury of neck, shoulder or wrist, and neurological impairments were excluded from the study.

Instrumentations

Biodex isokinetic dynamometer system "system 3pro" : Biodex System 3 Multi-Joint system testing and rehabilitation (Biodex Medical system, Shirley, NY, USA) was used for open kinetic chain isokinetic testing to measure shoulder flexion and extension peak torques at angular velocity (60º/sec) with concentric/concentric concentric/eccentric mode of contraction. Measures were automatically recorded by the system's custom software.

Procedures

Isokinetic testing of shoulder flexion and extension

A single trained investigator evaluated all the persons and collected all the data to eliminate inter-investigator error. A standard test protocol established to facilitate the reliability of the testing. Considerations include educating the patient regarding the particular requirements of the testing, testing the uninvolved side first, providing appropriate warm-ups and familiarization at determined velocity, being consistent in protocols and verbal instructions, using properly calibrated equipment, and providing appropriate stabilization.

Preparatory phase was involved in the current study to collect the data including name, age, weight, height, and BMI. Each participant received verbal orientation about the trials to be done. Shoulder flexion and extension were tested at speeds of 60 °/ sec through five consecutive repetitions of shoulder flexion, and extension. A period of stretching preceded each test. Each participant performed two trails for warm up and to be familiar with movement and instrument, each participant allowed for 45-60 seconds interval rest between trials, after finishing of isokinetic assessment give each participant 5 minutes for cooling down to avoid any test complication. All tests were performed from the sitting position with each subject stabilized with velcro straps. The joint's axis of rotation was aligned with the axis of motion of the dynamometer. Shoulder flexion and extension were tested through a range of motion from zero to 180 degrees. The isokinetic measures tested and utilized for the statistical analysis included peak torque (PT) at 60°/sec. Concentric/eccentric mode of contraction was selected from the control panel of computer unit. The gravity correction was performed according to weight of the limb.

Statistical analysis

All statistical measures were performed using the Statistical Package for Social Science (SPSS) program version 18 for windows. Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures. To determine similarity between the groups at base line, subject age, height, BMI and body weight were compared using independent T tests. The current test involved one independent variable. It was the tested group which had three levels (group A which suffered from tennis elbow, group B which suffered from Golfer’s elbow, and group C which was control). The two dependent variables were eccentric peak torque of shoulder flexors and shoulder extensors. Accordingly, "Between Subject MANOVA Design" was used to compare the tested variables of interest at different tested groups. Between Subject MANOVA design was conducted with the initial alpha level set at 0.05.

Results

Baseline and demographic data

As indicated by the One Way Analysis of Variance (ANOVA), there were no significant differences ($p>0.05$) in the mean values of age, weight, height and BMI among the three tested groups (Table 1).

Table 1. Descriptive statistics and One Way Analysis of Variance (ANOVA) for the mean age, weight, height and BMI values among the three tested groups.

	Group A (N=10)	Group B (N=10)	Group C (N=10)	F-value	P-value
Age (years)	25.5±3.27	24±5.21	26.85±4.48	0.68	0.521
Body weight (kg)	72.16±6.27	70.5±7.44	73±7.34	0.207	0.816
Height (cm)	170.66±4.54	167±4.64	171.57±5.47	1.503	0.252
BMI (kg/m²)	24.35±1.23	25.18±1.88	24.94±1.31	0.496	0.618

BMI: body mass index

Eccentric Peak Torque of Shoulder Flexors and Shoulder Extensors

Statistical analysis revealed that there were significant between subject effect ($F = 3.656$, $p = 0.015$*). Table (2) represents the mean ± SD and multiple pairwise comparisons for all dependent variables in three groups. The univariate tests revealed that there was no significant differences in the mean values of the "eccentric peak torque of shoulder flexors" among three groups with ($P>0.05$). While, there were significant differences in the mean values of the "eccentric peak torque of shoulder extensors among three groups with ($P<0.05$). So, multiple pairwise comparison tests revealed that there were no significant differences of eccentric peak torque of shoulder extensors between (Group A Vs. group B) and (Group A Vs. group C) with (p=>0.05) and there was a significant difference of eccentric peak torque of shoulder extensors between (Group B Vs. group C) and this significant reduction in favor to group B.

Table (2). Descriptive statistics and between subject MANOVA for the isokinetic peak torque of shoulder flexors and extensors among different groups.

	Group A	**Group B**	**Group C**
Flexors	51.33 ±3.55	54.5±5.12	50±3.78
Extensors	53 ±4.69	45.66±16.82	61.57±5.56
The univariate tests for the mean of the isokinetic peak torque of shoulder flexors and extensors among different groups			
	F-value	P-value	
Flexors	1.928	0.178	
Extensors	3.850	0.04*	
Multiple pairwise comparison tests (Post hoc tests) for the isokinetic peak torque of shoulder flexors and extensors among different groups			
	Group A Vs. group B	Group A Vs. group C	Group B Vs. group C
Flexors	0627	1.00	0214
Extensors	0.711	0.467	0.04*

*Significant at alpha level <0.05

Discussion

The statistical analysis revealed that there was no significant differences in the mean values of the eccentric peak torque of shoulder flexors among three groups with (P>0.05). While, there was significant differences in the mean values of the eccentric peak torque of shoulder extensors among three groups with (P<0.05). Multiple pairwise comparison tests revealed that there were no significant differences of eccentric peak torque of shoulder extensors between (Group A Vs. group B) and (Group A Vs. group C) with (p=>0.05), but there was a significant difference of eccentric peak torque of shoulder extensors between (Group B Vs. group C) and this significant reduction in favor to group B.

The findings of our study revealed that there was no difference in the shoulder flexors’ peak torque between athletic patients suffered from tennis elbow, golfer’s elbow and normal subjects, but there was a difference in shoulder extensors’ peak torque between athletic patients suffered from golfer’s elbow, and normal subjects.

Paul et al. [14] found that the co-activation of shoulder and elbow muscles was to be independent. Tonic EMG activity of shoulder muscles increased in proportion to shoulder movement, but was unrelated to elbow motion, whereas elbow and double-joint muscle co-activation varied with the amplitude of elbow movement and were not correlated with shoulder motion. In addition, tonic EMG levels were higher for movements in which the shoulder and elbow rotated in the same direction than for those in which the joints rotated in opposite directions.

The results of Wendy et al. [15] provide insight into the effect of shoulder range of motion and strength on pitching biomechanics, and found a greater internal-rotator strength and less external rotation motion were associated with increases in shoulder and elbow moments. A relationship also was identified between the peak shoulder and elbow moments in the throwing arm during pitching. This finding provides biomechanical support for addressing clinical shoulder characteristics as a potential strategy for prevention and rehabilitation of elbow injuries.

Harada et al. [16] who assessed risk factors for elbow injury in 294 youth baseball players aged 9 to 12 years. The risk factors for injury that they evaluated included clinical measures of motion and strength, age, height, mass, grip strength, grip strength ratio, position, years of throwing experience, number of pitches thrown, and number of days and hours of training per week. The participants were diagnosed with medial epicondylar fragmentation, and osteochondritis dissecans of the capitellum. The authors reported athletes were at risk for elbow injury, if their internal rotator strength exceeded 100 N. Harada et al. [16] hypothesized the greater strength could contribute to elbow injury by increasing upper extremity velocity and thus increasing distraction forces in the medial aspect of the elbow. The study of Wendy et al. [15] did not support this hypothesis, given that no relationship was found between internal-rotator strength and the elbow adduction moment.

Aguinaldo et al.[17] valuated 3D biomechanical analysis of the pitching motion in 69 uninjured adult baseball players. The authors reported maximum shoulder external rotation during the pitching motion was correlated positively with the peak elbow-valgus torque, with greater motion equating to higher torque. Sabick et al.[18] reported similar findings; maximum shoulder external rotation during the pitching motion was the best biomechanical predictor of peak elbow-valgus torque.

Wendy et al.[15] suggest that the increase in shoulder mobility as captured by clinically measured external rotation might result in lower joint stresses during pitching. The athlete who has less available external rotation and takes his shoulder to the end of the available joint motion during pitching might place an increased demand on the soft tissue structures of the shoulder and elbow. In the athlete with greater external-rotation motion, the peak motion during pitching might not be extended to the limits of the available joint motion. This would result in lower demands on passive joint stabilizers while increasing the demands on the dynamic muscular stabilizers to control joint motion.

Wendy et al.[15] found a strong relationship between the peak shoulder internal-rotation moment and the peak elbow adduction moment measured during pitching. Buss et al. [19] believe the coupling between these shoulder and elbow moments during pitching is due to limb positioning and geometry. Consequently, throwing athletes might be equally vulnerable to injury to both the shoulder and elbow, and this might provide insight into why athletes who return to play after injury at one site subsequently injure the adjacent upper extremity joint.

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