ACTA BIO MEDICA 2003; 74; 88-92 © Mattioli 1885

ORIGINAL ARTICLE

Evaluation of the peak torque, total work, average power of flexor-estensor and prono-supinator muscles of the elbow in baseball players

Cosimo Costantino, Enrico Vaienti, Francesco Pogliacomi

Section of Orthopaedic, Traumatology and Functional Orthopaedic Rehabilitation, Department of Internal Medicine and Biomedical Science, Parma Hospital, Parma, Italy

Abstract. The Authors, after a short analysis on biomechanics of the elbow during throwing in baseball, show the movements of the elbow during the different phases of the throw and the stabilizing action of the ulnar collateral ligament, flexor-pronator muscles of the wirst, anconeus and brachial triceps muscles. Aim of this study is the evaluation of the peak torque, total work and average power of the flexor-extensor and pronator-supinator muscles of the elbows in professional baseball players. Isokinetic test data show that a mayor peak torque in flexo-extension at power and resistence test in the pitchers compared to the strikers. Whereas the strikers show a higher peak torque in pronation at the resistence test. This may happen because during a baseball match the ball is hit many times by the bat and the pronator muscle of the wrist are notably stimulated and rinforced.

Key words: elbow muscles, isokinetic, peak torque, total work, average power, baseball

Introduction

Arm motion in throwing is an extremely violent movement. Perhaps no throw is more dynamic than baseball pitching, and, as a result, there is a high incidence of elbow injuries in pitchers (1). Recent survays have showed that injuries in professional and collegiate baseball players may result after years of overuse and repetition.

A recent study of collegiate baseball players in U.S.A., reported fifteen percent of athletes who had pitched with pain, tenderness or limited motion so compromising their ability to throw (2). The repetitiveness of baseball pitching results in high-risk of overuse injuries (3).

The complex pattern movement of throwing requires flexibility, muscular strenght, coordination, synchronicity of muscular firing and neuromuscolar efficiency (4).

The biomechanics of throwing and pitching are considered to be one of the most important factors that affect throwing perfomance and potential injury (5).

Pitching is combined in six phases: wind-up, stride, arm cocking, arm acceleration, arm deceleration, follow through. During wind-up phase, a minimal elbow movement is present.

In the stride phase, the elbow reaches eighty-five degrees of flexion. In the arm cocking, to stop the arm from externally rotationing too far, an eccentric internal rotation torque is necessary. The ulnar collateral ligament is believed to contribute to this varus torque together with contraction of the wrist flexor-pronator group, anconeus and triceps muscles. Between arm cocking and arm acceleration phases, the elbow is extended from approximately 85 to 20 degrees. Centrifugal force tries to distract the forearm out of the elbow joint but a compression force is ap-

plied to maintain elbow integrity (triceps, wrist flexor-pronator and anconeus).

In deceleration phase large loads are produced to decelerate the moving arm and prevent elbow distraction. The elbow is decelerated with a flexion torque before full extension is reached. The follow-through is a critical phase in minimizing the risk of injury in baseball pitcher. It is complete with elbow flexion and motion of the larger body parts, such as the trunk and legs. It helps to dissipate the accumulated energy in throwing arm.

Despite the growing popularity of the isokinetic instruments, no survay has measured the strenght in prono-supination and little information is available for flexo-extension (6-8).

Aim of this study is to evaluate by an isokinetic machine, the peak torque, total work, average power of flexor-extensor and pronator-supinator muscles of the elbow in baseball players.

Material and methods

At the Section of Orthopaedic, Traumatology and Functional Orthopaedic Rehabilitation of the Department of Internal Medicine and Biomedical Science of the University of Parma, 24 baseball players were tested by an isokinetic evaluation of their elbow.

All these atheletes are semi-professional and were playing in the first division of the Italian Baseball Championship and their age ranged from 20 to 30 years.

The athletes were not affected by any orthopaedic or neurological damage to their superior arms or cervical vertebrae. The peak torque, the total work and the power were considered bilaterally.

The elbow function was tested and a series of parameters expressed in numbers were obtained. These results allowed us to evaluate objectively the elbow strenght, its deficit and possible unbalance among muscular groups.

The tested movements were the flexo-extension and prono-supination at a low (90°/sec) and high angular speed (180°/sec.)

The athletes were seated and acted three repeated actions as a maximum. The test was performed with a precise sequelae of repetitions so as to reproduce constant trial conditions in all athletes. Before starting the test, they performed 5 submaximal repetitions to get familiar with the machine, to enable muscular warming up and prevent possible muscular damages.

A break of 3 minutes was allowed during the trials to help muscular recovery. The muscular strength was evaluated in concentric contraction.

In flexion and extension evaluation, the shoulder was in a position of 90° of abduction and movements were peformed on the horizontal plane in order to reduce gravitational effects. The elbow was allowed to move in a range of motion from 30 to 135 degrees of flexion-extension (Fig.1).

In prono- supination evaluation, the arm was pronated maximally , the elbow flexed of 90° and the range of evaluated motion was of 50° in both directions (Fig. 2).

The athletes were divided into 8 pitchers, and 16 strikers. Among them 9 athletes were left-handed and 15 right-handed. Among the pitchers 5 were right-handed, and 3 left-handed. Among the strikers 6 were left-handed and 10 right-handed.

The tests performed, showed an acceptable repeatibility, since the coefficient of variability was inferior to 10% (Fig. 3).

The results obtained were analyzed through T-test by Student for data which were not paired. A value of P inferior to 0.05 was considered relevant.

Figure 1. Isokinetic evaluation of the elbow in flexion-extension.

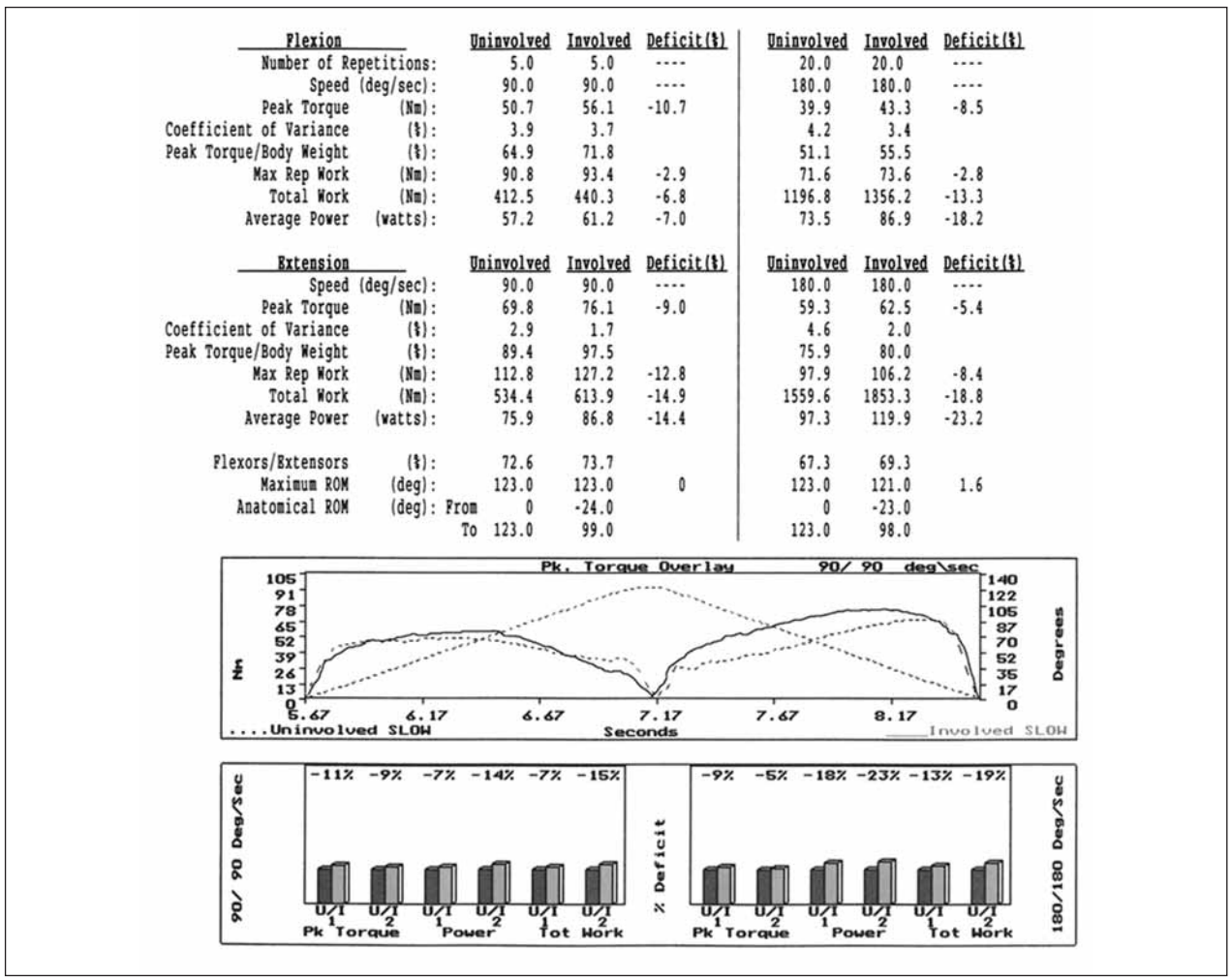
Figure 2. Isokinetic evaluation of the elbow in prono-supination.

From each group of pitchers and strikers, the dominant arm was taken into consideration.

Results

The results obtained were compared at a low (90°/sec.) and high angular speed (180°/sec.) for the peak torque and total work in flexo-extension and prono-supination. No relevant differences were noticed between pitchers and strikers in the peak torque and total work.

Whereas, regarding the only dominant right-hand arm in 5 pitchers and 10 strikers and in carrying



Flexion		Uninvolved	Involved	Deficit(%)	Uninvolved	Involved	Deficit(%)
Number of Repetitions:		5.0	5.0	----	20.0	20.0	----
Speed (deg/sec):		90.0	90.0	----	180.0	180.0	----
Peak Torque	(Nm):	50.7	56.1	-10.7	39.9	43.3	-8.5
Coefficient of Variance	(%):	3.9	3.7		4.2	3.4	
Peak Torque/Body Weight	(%):	64.9	71.8		51.1	55.5	
Max Rep Work	(Nm):	90.8	93.4	-2.9	71.6	73.6	-2.8
Total Work	(Nm):	412.5	440.3	-6.8	1196.8	1356.2	-13.3
Average Power	(watts):	57.2	61.2	-7.0	73.5	86.9	-18.2

Extension		Uninvolved	Involved	Deficit(%)	Uninvolved	Involved	Deficit(%)
Speed (deg/sec):		90.0	90.0	----	180.0	180.0	----
Peak Torque	(Nm):	69.8	76.1	-9.0	59.3	62.5	-5.4
Coefficient of Variance	(%):	2.9	1.7		4.6	2.0	
Peak Torque/Body Weight	(%):	89.4	97.5		75.9	80.0	
Max Rep Work	(Nm):	112.8	127.2	-12.8	97.9	106.2	-8.4
Total Work	(Nm):	534.4	613.9	-14.9	1559.6	1853.3	-18.8
Average Power	(watts):	75.9	86.8	-14.4	97.3	119.9	-23.2
Flexors/Extensors	(%):	72.6	73.7		67.3	69.3	
Maximum ROM	(deg):	123.0	123.0	0	123.0	121.0	1.6
Anatomical ROM	(deg): From	0	-24.0		0	-23.0	
	To	123.0	99.0		123.0	98.0	

Figure 3. Isokinetic evaluation of the elbow in baseball striker: coefficient of variabilty and values of the peak torque, average power and total work in flexion-extension.

on meaningfulness in flexo-extension and prono-supination, the peak torque and the total work in the above mentioned athletes varied.

The pitchers show a higher peak torque at 90°/sec in flexion compared to the strikers (p=0.003) with an average difference of 13%. The data were confirmed at 180°/sec. in flexion (p=0.002, +7.5%) (Fig. 4). In extension at 180°/sec. of angular speed, the pitchers showed a higher peak torque (+7%) compared to strikers (p=0.047). Strikers instead only showed a higher peak torque 17% in pronation at 180°/sec (p=0.021). For the peak torque meaningful variation was observed in extension at 90°/sec., in pronation at 90°/sec. and in supination at 90°/sec. and 180°/sec.

The total work did not show meaningful differences at different angular speed and in the different movements of flexo-estension and prono-supination.

Discussion

In scientific literature data regarding the peak torque of the agonist and antagonist muscles of the elbow in sportsman are not present.

Some scientific papers have tried to study the differences of the peak torque between young and old people. Gallagher et al. (8) studied the effects of age, testing speed and arm dominance on isokinetic strength of the elbow. Also Rodgers and Berger (9, 10) investigated peak torque for elbow flexion in 12 men at several different isokinetic speeds.

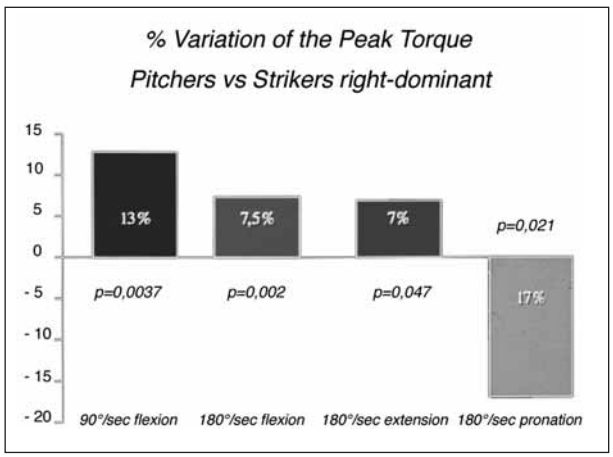


Figure 4. Isokinetic evaluation of the elbow and percentage differences of the peak torque.

In our study we haven't observed significative statistic differences in the peak torque of the prono-supinator and flexo-estensor muscles of the elbow between strikers and pitchers, apart from the dominant side. After the separation of the patients in two groups, right and left dominant arm, we have observed a higher peak of torque in the right-handed pitchers compared to the strikers in flexo-estension.

This is due to the specificity of the throwing, to the refined technique of the pitcher compared to the strikers and also from the great numbers of throwing which take place during a match. All these performances have a training effect and contribute to improve flexor-estensor muscles. Whereas the strikers show a higher peak torque in pronation at the resistence test. This may happen because during a match, the ball is hit many times by the bat and the pronator muscle of the wrist are notably stimulated and reinforced.

In our studies we have observed a higher peak torque of the flexors and pronators muscles. These overstressed muscles could be the cause of the development of medial epicondylitis.

As result is important to balance the muscular strength of all the muscles of the elbow and power the antagonist muscles (extensor and supinator) to avoid this medial overstress. Isokinetic test is important to evaluate the muscular balance of the muscles of the elbow and, if necessary, to plan an adequate rehabilitative program.

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Received: 14 May 2003
Accepted in original form: 16 June 2003
Correspondence: Cosimo Costantino, MD
Section of Orthopaedic, Traumatology and Functional Orthopaedic Rehabilitation. Department of Internal Medicine and Biomedical Science. University of Parma
Parma Hospital, Via Gramsci 14
43100 Parma, Italy
E-mail: cosimo.costantino@unipr.it