RETROTORSION OF THE HUMERUS IN THE THROWING ARM OF HANDBALL PLAYERS - AN ADAPTATION TO UNILATERAL STRAIN

Hans-Gerd Pieper, Alfried-Krupp Krankenhaus, Essen, Germany

INTRODUCTION: As compared to the axis of the elbow joint, the humeral head is directed inward and backward. This is called *retroversion* of the humeral head or *retrotorsion* of the humerus respectively (13).
Orthopaedic interest in humeral torsion goes back to the 70's. In 1971 DEBEVOISE et al. were the first to suggest a relationship between humeral torsion and shoulder instability (3). Our own studies on this subject started in 1976 (13-16). Meanwhile, we have measured the angle of humeral retrotorsion in more than 300 patients with recurrent anterior shoulder dislocations by X-ray and compared the values with those of 240 shoulders without shoulder problems. The dislocating shoulders were found to exhibit angles that were smaller by 11.3° on the average as compared to the control group (18), meaning that the articular surface of the humeral head is directed more anteriorly in unstable shoulders than it is in stable ones. Our results were later confirmed by other groups either using CT-scan (4, 5) or radiologically (10, 11, 19).
When comparing the maximum amount of external shoulder rotation of the throwing arm of handball players to that of the non-dominant side, in almost every handball player an increase of about 10 - 15° of external rotation can be found in the throwing arm (17). This fact by itself is not surprising, because it could be explained by anterior laxity due to chronic overuse, i.e., stretching the joint capsule and ligaments. If anterior laxity was indeed the sole cause for the difference in external rotation ability, however, the amount of internal rotation should not be affected. Yet among our subjects we observed a considerable reduction of maximum internal rotation of the dominant arm (17). Differences of about the same magnitude (approximately 10°) have been reported for unilateral overhead or throwing sports like tennis (1,2) or baseball (12). In the literature, these findings have been explained by a tightening of the posterior capsule by means of fibrotic changes (2); however, a plausible explanation for this shrinking has not been established yet, since the athletes use their arms normally in everyday life without avoiding movements involving internal rotation (e.g., hygiene care).
The aim of the present study was to investigate whether:
I) this lateral difference can be explained by an osseous component, i.e., a side difference in the torsional angle of the humerus, and
II) the existence or non-existence of such a side difference could be a major factor in the occurrence of chronic shoulder problems in handball players.

MATERIALS AND METHODS: In order to investigate this question further, the angle of humeral retrotorsion was determined in both shoulders of 51 male handball professionals, 39 of them right-handed and 12 left-handed. 45 were first league players, 34 of them had played in their national handball teams. The other six are players of junior national teams, one from Poland, one from Hungary, the other four German. The age distribution ranged from 18 to 39 years, with an average of 27 years. All players had started competitive handball before the age of

10. They had to have at least 5 years of team competition to be included in our study. 38 of them had no history of shoulder problems, while 13 players complained of chronic shoulder pain.
Humeral retrotorsion was determined by X-ray in two defined planes. The true torsion values were taken from a correction table similar to the one used by Rippstein in determining femoral antetorsion (14, 15). The validity of this X-ray method was proven to be very high (correlation between angles measured on bone directly and determined by X-ray: $R = 0.97$) (13).
The side differences were compared to values of a control group of 37 men without any history of shoulder instability or unilateral strain due either to sports or profession.

RESULTS: In the group of 38 handball players without chronic shoulder pain, the retrotorsional angle of the humerus was 14.4° larger on the dominant side than on the non-dominant, the difference ranging from 3° to 29°. The difference is highly significant ($p < 0.001$). In the control group, however, we could not find a statistical significance, with the average increase being only 1.8°. This finding is in line with KRONBERG et al., who reported an increase of 4° in the dominant arm of 50 non-athletes (11).
The group of handball players with chronic shoulder pain did not exhibit this increase. They even showed a decrease in humeral retrotorsion of 5.2° in the throwing arm. As compared to the group of 38 handball players without chronic shoulder pain, this was again statistically significant.

DISCUSSION: How can these findings be explained? Nearly 100 years ago, in 1897, HULTKRANTZ already knew that "... the way of living, activities (e.g., throwing), influence the individual transformation of the humeral bone" (6). As an adaptational process in the dominant arm of tennis professionals, JONES et al. reported a widening of cortical thickness of the humeral shaft by 34.9 % in men and 28.4 % in women (7). In 1994 our group reported a limb lengthening in tennis professionals' dominant arms (9).
Since the beginning of this century, we have known that muscle action is the cause of humeral torsion. WERMEL showed in 1935 that there is a relationship between the function of the hand and humeral torsion in rabbits by cutting off certain muscles during animal growth and later comparing humeral torsion (20).
In the USA, KRAHL did studies on the relationship between humeral torsion and the muscle tension of the rotators. He found that "contractions of the humeral rotators tend to cause a turning of the shaft with respect to the proximal epiphysis. Although [these forces are] too weak to produce displacement [of the epiphyseal disk], they may well have a formative influence in directing the growth of new bone in a spiral fashion" (8). He concluded that an increase in muscle tension of the external rotators leads to a lateral rotation of the distal humerus and thus to an increased humeral retrotorsion.

CONCLUSION: The increase of humeral retrotorsion in the throwing arm of handball players seems to be an adaptational process due to extensive external rotation in throwing practice during growth. This increase of retrotorsion allows more external rotation of the shoulder before the humeral head puts excessive strain on the anterior capsulolabral complex, and thus may lead to anterior

instability. An increase of humeral retrotorsion could thus be interpreted as a protection mechanism for the anterior capsulolabral complex.
Those athletes who – for some reason yet unknown to us – do not exhibit this biopositive response to practice in childhood seem to have more strain on their anterior capsule at an earlier degree of external rotation and thus might be prone to develop chronic shoulder pain due to anterior instability.

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