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Summary

Objective: Our objective was to investigate the influence of workload and consecutive changes on active range of motion and isometric strength of team handball athletes' throwing shoulders (TSs) because the available data are insufficient.

Methods: In a longitudinal investigation, 31 professional male handball athletes underwent a clinical shoulder examination. Athletes were examined at the beginning (week 0), at the end (week 6) of the preseasonal training, and at the end of the halfseason (week 22) on both shoulders to determine isometric rotational strength (hand held dynamometer) and active range of motion (goniometer).

Results: This analysis demonstrates the results subsequently from week 6 to week 22 and from week 0 to week 22. The glenohumeral internal rotation (IR) deficit (GIRD), external rotation (ER) gain, and ER at the TS increased significantly ($P < .05$, $\eta^2 > 0.10$, $d > 0.30$) in the first sequence (week 6 to week 22) but not significantly from week 0 to week 22. The total range of motion remained stable, and IR changed but not significantly. There was no influence on IR, ER, and total range of motion at the non-TS. The isometric strength of the TS and non-TS IR did not change. The isometric strength in ER significantly increased bilaterally during the investigation period.

Conclusions: Our data verify changes and influences, such as an increasing GIRD, at the overhead TS joint in accordance with the workload during team handball season. ER gain did improve after the halfseason period but did not fully compensate the GIRD at the TS.

Level of evidence: Basic Science, Kinesiology.

Keywords
Overhead sports injury– thrower's shoulder– rotation capacity– glenohumeral internal rotation deficit (GIRD)– external rotation gain (ERG)

Zusammenfassung

Hintergrund: Ziel unserer Studie war den Einfluss einer Spielsportbelastung auf konsekutive Veränderungen in der aktiven Rotationsbeweglichkeit und isometrischen Kraft an Wurfarm-Schultergelenken (TSs) bei Handballathleten zu untersuchen, da

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Reprint of: Range of motion and isometric strength on shoulder joints of team handball athletes during the playing season, part II: changes after midseason☆,☆☆

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The sport of team handball has one of the highest injury risk rates in Germany, with a percentage of 15.2% in sports overall, and is comparable to basketball and volleyball, following soccer [30]. Even severe traumas, such as compartment syndromes in the thigh, are described in team handball [13]. Studies indicate occurrence of 30% acute and 45% chronic symptoms and incidents at the throwing shoulder (TS) in team handball, which is one of the affected anatomic regions, especially in overuse syndromes and pain [5,20,30,31,37]. During a complete season, a professional team handball athlete performs up to 48,000 throwing actions with a maximum speed up to 130 km/h and an angular velocity of 7.000°/s, which means 20 turns/min and 150 to 170 km/h at the throwing hand [29,31]. Fleisig et al [14] reported the forces on the anatomic structures of the TS during an action is up to 1.5-fold of the body weight. Cinematic studies for investigation of a throwing action showed that in disciplines, such as team handball sports, the highest stress on the structures in the shoulder joints is correlated to the cocking and deceleration phase (Fig. 1) [25,43]. The cocking phase might be the more intense position based on forces applied to the structures, but because of different techniques in throwing, such as jump throw, standing throw, standing throw with run-up, hip throw, or pivot throw,

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☆ The work is part of a study that was approved by the Research Ethics Committee of the University of Medicine of the Federal University of Halle-Wittenberg, Germany (study 2013–13).

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diesbezüglich nur wenig Literatur vorhanden ist.
Material und Methoden: In einer longitudinal angelegten Studie wurden 31 professionelle männliche Handballsportler an ihren Schultergelenken klinisch untersucht. Bei den Athleten wurden zu Beginn (Woche 0) und am Ende (Woche 6) der Saisonvorbereitung sowie nach Abschluss der Hin-Serie (Woche 22) an beiden Schultergelenken (Wurfarm = Throwing (TS), Nicht Wurfarm = Non Throwing Shoulder (non-TS)) die isometrische Kraft mit einem Hand-Dynamometer sowie die aktive Rotationsbeweglichkeit mit einem Goniometer bestimmt.
Ergebnisse: Diese Analyse beschreibt die sequentiellen Ergebnisse von Woche 6 zu Woche 22 sowie von Woche 0 zu Woche 22. Das glenohumerale Innenrotationsdefizit (GIRD), die Außenrotations- (ER) und –erweiterung (ERG) vergrößerten sich an der TS signifikant ($P < .05$, $h2 > 0.10$, $d > 0.30$) in der ersten Sequenz (Woche 6 zu Woche 22), allerdings nicht signifikant von Woche 0 zu Woche 22. Die Gesamt-Rotationsbeweglichkeit (ROM) blieb stabil, die Innenrotation (IR) veränderte sich nicht signifikant. Es konnte kein Einfluss auf IR, ER und ROM an der non-TS festgestellt werden. Die isometrische Kraft an der TS und non-TS veränderte sich in der IR nicht. Die Kraft in ER steigerte sich signifikant an beiden Schultergelenken über beide Beobachtungszeiträume.
Schlussfolgerungen: Unsere Daten belegen den Einfluss und Veränderungen, wie die Erhöhung eines GIRD an Schultergelenken unter der Belastung einer Handballsaison. Eine ERG wird ebenfalls vergrößert nach einer halben Spielsaison, kompensiert jedoch nicht vollständig ein glenohumerales Innenrotationsdefizit (GIRD) an einer Wurfarmschulter.
Evidenzebene: Grundlagenwissenschaft, Bewegungslehre.

Schlüsselwörter
Überkopfsport-Verletzungen – Werferschulter – Rotationsbeweglichkeit – glenohumerales Innenrotationsdefizit (GIRD) – Außenrotationserweiterung (ERG)

Figure 1
Center player in jump-shot motion.

Figure 2
Right humeral head of a former team handball goalkeeper (42 years old) after 25 years of active sport.

which phase of a throwing action causes the strongest workload is unclear [43]. The consequences of these intense loads in maxima of rotation and angular velocity are changes in rotational capacities as well functional and structural adaptations in the affected shoulder joint [38,39,45]. These processes encompass a reduction in internal rotation (IR) and an extension in the external rotation (ER) distance compared with the non-TS (NTS) joint [3,11].
Various authors have described these reactions as osseous adaptations via retroversal positions of the humeral head (Fig. 2) [4,8,28,29,31,32,35]. Other studies suggest an attenuation and weakness of the anteroinferior capsule and ligament tissues at the TS due to the ongoing workload, which goes along with impressions of "pseudolaxity." In consequence, the situation might occur in a "posterosuperior glenohumeral impingement syndrome," as described by Jobe [17] and Walch et al [44].
Alternatively Burkhart et al [6,7] introduced a pathophysiologic concept with contractures of the posteroinferior capsule and posterior part of the inferior glenohumeral ligament as well as a shift of the center of rotation for the humeral head to posterosuperior as a current model of explanation [2]. A factor of predisposition to generate structural lesions at the glenohumeral joint is the glenohumeral IR deficit (GIRD), as described by Burkhart et al [6,7]. There is evidence for the presence of a GIRD as a primary risk factor for shoulder injuries and damages [26,41,42].
Regardless which pathologic mechanism best reflects the influences, there is evidence for the development of internal posterosuperior glenohumeral impingement syndromes, superior labrum anterior to posterior lesions, and anterior instability from an overhead TS because of an overuse causing microtraumatic lesions [2,6,7,46]. Wilk et al [45] first proposed a reproducible and reliable concept and method to examine overhead athlete's shoulders with evaluation of a total range of motion (tROM) as a sum of the IR and ER in 900 arm