THE COMPAREMENT OF LOWER LEG SPEED TT RESULTANT AT HANDBALL JUMP SHOTS DURING REBOUND AND LANDING, AS POSSIBLE ANTERIOR CRUCIATE LIGAMENT INJURY PREVENTION

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Abstract

In this study we did comparative analysis of handball jump shots at goal by taping first federal league players. Jump shots are one of basic elements in handball techniques and have serious attention both in teaching and in training. To realise this project and to process video tape, we used three-dimensional kinematic analysis which enabled total speed TT counting of lower leg in knee joint of rebound-landing feet during handball throw jump shot: straight ahead, with drift (eret) and upward. The aim of this study was to, on the basis of obtained data on mechanical characteristics of knee joint and lower leg centre speed, determine statistically significant difference in speed TT resultant of lower leg (Voter) at rebound and landing during handball throw jump shot: straight ahead, with drift (egret) and upward, which will bring ACL injury prevention to a higher level. On the basis of research results and stated hypothesis we obtained facts that there are certain statistically significant differences in mechanical characteristics of knee joint and speed TT resultant of lower leg (Voter) at rebound and landing during all three handball jump shots so that hypothesis H0 can be partially accepted. Statistically significant difference in lower leg centre total speed is determined during handball jump shot, straight ahead and upward jump shot; with drift (eret) and straight ahead, at rebound and landing. At the same time, there was not statistically significant difference in lower leg speed TT resultant during handball jump shot with drift and upward, at rebound and landing.

Key words*: handball jump shots, lower leg, ACL prevention*

Introduction

Handball is an aerobic-anaerobic sport, characterised by a phase with high demand, such as: sprints, quick exchange of movement direction, jumps with landings and various kinds of falls as well as sudden stops. Beside that, there are various techniques in changeable situations and they arise intentionally and unintentionally during handball game. Today's ultimate handball demands strong and stabilized sportsman with high level of motor and functional abilities, sense of creativity and collective play. The aim of this investigation was to, on the basis of obtained data on mechanical characteristics of knee joint, and lower leg centre speed, determine statistically significant difference in speed TT resultant of lower leg (VTbR) at landing and rebound during handball throw jump shot straight ahead, with drift (eret) and upward, bringing all injury prevention to the higher level. O.E.Olsen at all (2003) in their work «Relation between floor type and risk at all injury in team handball» compare level of all injuries between two different types of floor-wooden (parquet, generally with lower friction) and artificial floors (generally with higher friction).

They registered all injuries in three high-level leagues for women and men in Norway team handball during 7 seasons (1989-2000). They also registered total of 174 all injuries, of that 53 happened in regional league matches. Types of floor in all regular games of the same season were determined retrospectively according to game schedule. Games were divided into two types- those played on wooden floors and those played on artificial floors. Among men, 9 injuries happened (incidence: 0,24+/- 0,09 injuries at 1000 players per hour); 44 injuries at women (0,77 +/- 0,04 injuries at 1000 players per hour) or, in relation to men (3,21 (1,56 – 6,58); P=0,001). Among men, 4 injuries happened on wooden floors ((0,32 +/- 0,13 injuries at 1000 players per hour) and 5 injuries on artificial floors (0,20 +/- 0,12 injuries at 1000 players per hour) or, in relation to wooden floors: 0,63 (0,17 – 2,37); ns. Among women, 8 injuries happened on wooden floors (0,41 +/- 0,09 injuries at 1000 players per hour; or in relation to men: 1,29 (0,39 – 4,28); ns) and 36 injuries on artificial floors (0,96 +/- 0,04 injuries at 1000 players per hour; or, in relation to wooden floors; 2,25 (1,87 – 12,18); P=0,001).

Those results show that risk of all injuries for women is higher on artificial than on wooden floors. C.Reckling et all (2003) in study »Epidemiology of injuries at junior handball players« posted as aim of investigation the clearance of epidemiology aspects and mechanism of injuries in junior handball. The used standard questionnaire for evaluation of injuries at 100 junior players (50 male, 50 female, aged 1982/83). 130 injuries at 73 players were registered. Most of injuries (73,1 %) happened to players 15 to 18 years old. Approximately two thirds of injuries (69,2 %) happened on contest and most of them in offensive situation. Defenders (29,0 %), line players (27,5 %) and goal keepers (17,0 %) were the positions with most injuries. Women goal keepers had three times more often injuries than men of the same age.

Most of injuries were at foot and ankle (32,0 %). The most ankle injuries were lateral ligament ruptures. Knee joint is hit by the most serious injuries with required surgical intervention. The most common injury of knee joint was the rupture of anterior cruciate ligament (ACL). Eleven ACL ruptures were registered at the age of 15 to 18 years (12-14 years: 1; 8 – 12 years: 0). The most typical situations in play at the moment of injury were: catching ball (38,5 %), contract with opponent (34,5 %) and landing after jump (26,2 %). This study enables conclusions relevant to prevention of injuries at junior handball. It is obvious that there is the difference in muscle strength and coordination of young handball players; especially aged 15-18 years and they need special attention. Thus, authors recommend proprioceptive training program, to improve jump techniques. Special training for consolidation of finger muscles could help in prevention of finger injuries. Frequency of contact injuries lays in importance of »FAIR PLAY« campaign among players. W. Petersen et all (2003) in project »Prevention of handball lower extremity injuries« stated that lower extremity injuries lead to inability too perform sport activities and can cause degenerative changes in joints. Thus they developed specific prevention programme for European handball and tested it in the following study. One handball club (second league) performed proprioceptive and neuromuscular training during preseason. The programme consists on three different components: 1. information on mechanism of injury, 2. proprioceptive training and 3. jump training. During season, training continued with lower intensity. Other handball team which did not perform preventive training served as control group. At study retrospective we compared serious injuries frequency in training season to serious injuries in the last season. At the last year not one team player suffered serious ankle or knee injury. In the last season, 3 sportsmen had all rupture. In the control group with no training, one sportsman suffered all injuries and one suffered lateral ligament rupture, these findings does not have statistical significance because of small number of examinees. Nevertheless, incidence of easy and medium injuries was statistically lower in the group with injury prevention. This study shows that proprioceptive and neuromuscular training is adequate for lower extremities injury prevention. Prevention strategy should be included in routine programme for handball players training. G. Kozomara, S. Arnautović (2005) in this study, you can see parallel analysis of jump-shots at goal in handball, which has been made during monitoring players of First federal league. The jump-shots are the one of the basic elements of technique in handball, and they are the most important ones in the process of training or coordinating the game. In order to accomplish the project, we treated the video record by three-dimensional kinematics analysis.

In that way, it was possible to calculate the total speed of TT lower leg in the knee ankle when a player kick the ball correlate the jump-shot in three positions: long jump; deviation jump (eret); and high jump. On the basis of data about mechanical characteristics of ankle, the purpose of the study was to determinate statistically important differences in resultant of speed TT lower leg at rebound, correlate the jump-shot in three positions long jump, deviation jump (eret), and high jump. On the basis of mechanical characteristics of ankle and resultant of speed TT lower leg at rebound, the results of research showed statistically important differences, correlate for all three types of jump-shots, and because of that the HO yero hypothesis can be accepted partially. There was statistically important difference in total speed TT lower leg at rebound, which has been established correlate when player kicks ball by jump-shot in two positions: long jump and high jump, and by deviation jump (eret) and long jump, while there wasn't any important difference in resultant of speed TT lower leg, correlate jump shot by deviation jump (eret) and high jump.

Problem and aim

Main investigation problem was to determine mechanical regularity existing in knee joint as well as what is the speed of lower leg centre at rebound-lending foot during rebound and landing, by performing all three kinds of jump shots in handball. Object of investigation were kinematics parameters manifested in lower leg and in knee joint of rebound-landing feet.

The aim of investigation was to, on the basis of obtained data on mechanical characteristics of knee joint and lower leg centre speed, determine statistically significant difference in speed TT resultant (VTbR) at rebound and landing, during handball throw in jump shot: straight ahead, with drift (eret) and upward, which move injury prevention to a higher level.

Methods

Examinee, who demonstrated all three jump shot techniques in handball, was engaged from the group of players of higher range contest, to be more precise, from the first federal league. He was in excellent form and ale to ideally perform all kinds of throws in handball sport. Speed TT variables of lower leg in rebound-landing feet: 1. lower leg speed TT in frontal line VTbx, 2. lower leg speed TT in sagital line VTby, 3. lower leg speed TT in vertical line VTbz, 4. speed TT resultant of lower leg RVTb. TT- is The point at the very centre of (his) mass, in fact, total body mass centre. At the case of, for example, quadric or cylinder where the mass is equally distributed, that point is at geometrical centre of the body, but, if the mass isn't equally distributed, as it is in human body extremities, the centre of mass will be closer to the bigger and heavier part of extremity. We used programme for kinematics analysis in 3D space for videotape processing. Objective technique was taped with two cameras. Video tape was then processed and prepared for further work, considering determination of referent points on 14 model system. Obtaining basic coordinates of orthogonal coordinate system for each camera, we did direct linear transformation, thus getting coordinates of referent points in 3D space. After that, kinematics values were calculated. To answer posted hypothesis, according to the presented object and aim of work, we did following statistical processing: Descriptive statistics which calculated: Mean value (Mean-X), Standard deviation (Std.Dv.-SD), Minimum (min) and Maximum (max), and range t- test differences of arithmetic midpoint for two small depending samples.

Results

Table 1. Descriptive statistics

Descriptive statistics of total speed value at rebound (m/s)		Descriptive statistics of total speed value at landing (m/s)	
VTbRStr.ah.		VTbRStr.ah.	
Mean	2.92	Mean	2.57
Std.Dv.	1.35	Std.Dv.	1.19
min	0.91	min	0.94
max	5.08	max	4.82
range	4.17	range	3.89
VTbREret		VTbREret	
Mean	2.02	Mean	1.85
Std.Dv.	0.92	Std.Dv.	0.82
min	0.61	min	0.8
max	3.55	max	3.56
range	2.94	Range	2.76
VTbRUpw.		VTbRUpw.	
Mean	2.34	Mean	1.74
Std.Dv.	1.28	Std.Dv.	0.74
min	0.33	min	1.15
max	4.22	max	3.39
range	3.89	range	2.24

Table 2. Time intervals of total speed values

T. Int.	VTbR Str-ah.rebound m/s	VTbR Eret rebound m/s	VTbR Upw. rebound m/s	VTbR Str. ah.landing m/s	VTbR Eret landing m/s	VTbR Vis. landing m/s
1	5.08	3.15	4.22	4.82	3.56	3.39
2	4.75	2.91	4.22	4.39	3.12	3.18
3	4.21	2.64	3.58	3.46	2.72	2.68
4	3.77	2.45	2.14	2.74	2.65	2.18
5	3.19	2.03	1.54	2.38	2.31	1.94
6	2.49	1.77	1.40	2.02	1.91	1.73
7	1.86	1.50	1.29	1.69	1.70	1.42
8	1.49	0.97	0.54	1.23	1.67	1.17
9	1.05	0.61	0.33	0.94	1.68	1.15
10	0.91	0.78	1.43	1.24	1.63	1.20
11	1.79	1.30	2.98	1.59	1.57	1.20
12	2.92	1.84	3.35	1.85	1.42	1.22
13	3.51	2.75	2.95	2.30	1.11	1.31
14	3.80	3.55	2.80	3.02	0.88	1.41
15		3.96	2.80	3.60	0.83	1.36
16				3.89	0.80	1.34
17						1.33

Table 3. Speed TT resultant of lower leg during handball throw jump shot: straight ahead and upward at landing (p = 0,018449 < 0,05; t = 0,05 = 2,18; N = 14)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Str.ahead	2.9174	1.3517						
VTbR Eret	*2.3414*	*1.2825*	*14*	*0.5760*	*0.5921*	*2.6927*	*13*	*0.0184*

Table 4. Speed TT resultant of lower leg during handball throwing in jump shot: straight ahead and with drift-eret at rebound (p = 0,000076 < 0,05; t = 0,05 = 2,18; N = 14)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Str.ahead	2.9174	1.3517						
VTbR Eret	*2.0191*	*0.9213*	*14*	*0.8983*	*0.5921*	*5.6765*	*13*	*0.0001*

Table 5. Speed TT resultant of lower leg during handball throw in jump shot: upward and with drift-eret at rebound (p = 0,175317 > 0,05; t = 0,05 = 2,18; N = 14)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Upward	2.3414	1.2825						
VTbR Eret	*2.0191*	*0.9213*	*14*	*0.3223*	*0.8413*	*1.4335*	*13*	*0.1753*

Table 6. Speed TT resultant of lower leg during handball throw in jump shot: straight ahead and upward at landing (p = 0,000772 < 0,05; t = 0,05 = 2,14; N = 16)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Str.ahead	2.5740	1.1858						
VTbR Upward	*1.7423*	*0.7376*	*16*	*0.8317*	*0.7920*	*4.2003*	*15*	*0.0008*

Table 7. Speed TT resultant of lower leg during handball throw in jump shot: straight ahead and with drift-eret at landing (p = 0,022796 < 0,05; t = 0,05 = 2,14; N = 16)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Str.ahead	2.5740	1.1858						
VTbR Eret	*1.8480*	*0.8233*	*16*	*0.7259*	*1.1447*	*2.5366*	*15*	*0.0228*

Table 8. Speed TT resultant of lower leg during handball throw in jump shot: with drift-eret and upward at landing (p = 0,279794 > 0,05; t = 0,05 = 2,14; N = 16)

	Mean	Std.Dv.	N	Diff.	Std.Dv.Diff.	t	df	p
VTbR Eret	1.8480	0.8233						
VTbR Upward	*1.7423*	*0.7376*	*16*	*0.1058*	*0.3773*	*1.1213*	*15*	*0.2798*

At table for rebound, we can see that mean total speed values for centre movement of lower leg are highest at jump shot: straight ahead, upward and with drift-eret (2,92 m/s, 2,34 m/s, 2,02 m/s, respectively). Thus, standard deviation and range of minimum and maximum speed values for lower leg have the same range of speed values as well as mean value, jump shot straight ahead, jump shot upward and jump shot with drift-eret, SD (1,35 m/s, 1,28 m/s, 0,92 m/s, respectively), and ranges (4,17 m/s, 3,89 m/s, 2,94 m/s, respectively). Looking at the table for landing, we can see that mean total speed values for centre movement of lower leg are highest at jump shot straight ahead, but followed by jump shot with drift-eret and jump shot upward (2,57 m/s, 1,85 m/s, 1,74 m/s, respectively). Following range of mean speed values, standard deviation and minimum and maximum speed values range at lower leg show the same speed values trend, jump shot: straight ahead, with drift-eret and upward, SD (1,19 m/s, 0,82 m/s, 0,74 m/s, respectively), and ranges (3,89 m/s, 2,76m/s, 2,24 m/s, respectively).

Mean total speed TT value of lower leg at rebound performing handball jump shot straight ahead is 2,92 m/s and in jump shot upward is 2,34 m/s. the difference is 0,58 m/s favouring jump shot straight ahead which has higher total speed TT value of lower leg. t- test is 2,69 and over-crosses the range of significance showing that there is statistically significant difference between speed TT total value of lower leg during handball throw in jump shot: straight ahead and upward. Mean speed TT total value of lower leg at rebound during performing jump shot straight ahead in handball is 2,92 m/s and jump shot with drift-eret is 2,02 m/s.

The difference is 0,9 m/s favouring jump shot straight ahead which has higher speed TT total value of lower leg. t- test is 5,68 and over-crosses the range of significance showing that there is statistically significant difference between speed TT total value o lower leg during handball throw in jump shot: straight ahead and with drift-eret. Mean speed TT total value of lower leg at rebound during performing handball jump shot upward is 2,34 m/s and during jump shot with drift-eret is 2,02 m/s. the difference is 0,32 m/s favouring jump shot upward which has higher speed TT total value of lower leg. t- test is 1,43 and does not cross range of significance, showing that there is not a statistically significant difference between speed TT total value of lower leg during handball throw in jump shot: upward and with drift-eret.

Mean speed TT total value of lower leg at landing during handball jump shot straight ahead is 2,57 m/s and during jump shot upward is 1,74 m/s. The difference is 0,83 m/s favouring jump shot straight ahead which has higher speed TT total value of lower leg. t- test is 4,20 and over-crosses the range of significance thus showing that there is statistically significant difference between speed TT total value of lower leg during handball throw in jump shot: straight ahead and upward at landing. Mean speed TT total value of lower leg at landing performing handball jump shot straight ahead is 2,57 m/s and performing jump shot with drift-eret is 1,85 m/s. The difference is 0,72 m/s favouring jump shot straight ahead which has higher speed TT total value of lower leg. t- test is 2,54 and over-crosses the range of significance showing that there is a statistically significant difference between speed TT total value of lower leg during handball throw in jump shot: straight ahead and with drift-eret at landing.

Mean speed TT total value of lower leg at landing performing handball jump shot with drift-eret is 1,85 m/s and performing jump shot upward is 1,74 m/s. The difference is 0,11 m/s favouring jump shot with drift –eret which has higher speed TT total value of lower leg. t- test is 1,12 and does not over-cross the range of significance so that there is not a statistically significant difference between speed TT total value of lower leg during handball throw in jump shot: with drift-eret and upward at landing.

Discussion and conclusion

On the basis of this research results and posted hypothesis, one can evolve following conclusions:

- There are certain statistically significant differences in mechanical characteristics of knee joint and speed TT resultant of lower leg (VTbR) at rebound and landing during handball throw in jump shot: straight ahead, with drift-eret and upward, so that null hypothesis H0 can be partially accepted.
- Speed TT resultant of lower leg at rebound and landing, statistically significantly differ at handball throw in jump shot straight ahead and jump shot upward, so that hypothesis H1 can be accepted.
- Speed TT resultant of lower leg at rebound and landing, statistically significantly differ at handball throw jump shot straight ahead and jump shot with drift (eret) so that hypothesis H2 can be accepted.
- speed TT resultant of lower leg at rebound and landing statistically significantly does not differ at handball throw jump shot upward and jump shot with drift (eret), so that hypothesis H3 is rejected.

Statistically significant difference in speed TT resultant of lower leg at landing, obtained by comparing handball throw jump shot straight ahead to jump shot upward and jump shot with drift (eret), was conditioned with higher speed player engaged during rebound in handball throw jump shot straight ahead as well as direction and course of movement at landing, of course all that intended to score a goal. Partial acceptance of hypothesis H0 shows that speed changes at rebound and landing of lower leg, performing handball jump shots at goal are most distinct and because of that, they should be well considered.

This becomes even more significant considering present investigations and general conclusion that lower leg movement in relation to body centre is the most significant for knee injuries. Knee is one of the most massive joints and one of the most important ones for sportsmen. Earlier works concluded that lower leg, as part of knee joint in case of its enormous movement and non-stable landing during enormous body pressure forward with acceleration, can lead to ACL rupture.

Prevention of all injuries is even more important not forgetting that latest statistical data here and worldwide suggest that ACL injury is one of the most common knee injuries and if not properly surgically solved, it can permanently remove an active sportsman from performing sport. This work investigation was directed to what segment of rebound-landing feet suffers highest speed changes during all three jump shots at goal in handball. It shows that it is lower leg that has enormous part in knee stability at rebound and landing.

References

Kozomara, G., & Arnautović, S. (2005).*The difference in spead resultant of lower leg TT during rebound at handball jump shot*. Niš: FIS communications.

Olsen O.E., Myklebust, G., Engebretsen, L., Holme, I., & Bahr, R. (2003). Relationship between floor type and risk of ACL injury in team handball. *Medicine and Science in Sports,* 13(5):299-304.

Petersen, W., Zantop, T., Steensen, M., Hypa, A., Wessolowski, T., & Hassenpflug, J. (2003). Prevention of lower extremity injuries in handball: initial results of the handball injuries prevention programme. *Sportverletz Sportschaden*. 16 (3):122-6.

Reckling, C., Zantop, T., & Petersen, W. (2003). Epidemiology of injuries in juvenile handball players, *Sportverletz Sportschaden*. 17 (3):112-7.

USPOREDBA RAZLIKE U REZULTANTI BRZINA TT POTKOLJENICE KOD SKOK ŠUTEVA U RUKOMETU PRI ODSKOKU I DOSKOKU KAO MOGUĆNOST PREVENCIJE POVREDE ANTERIOR CRUCIATE LIGAMENTA

Sažetak

U ovoj studiji, izvršena je usporedna analiza skok šuteva na gol u rukometnom sportu, snimanjem igrača I savezne lige. Skok šutevi su neki od temeljnih elemenata tehnike u rukometu i njima se u procesu obučavanja, treniranja ili uigravanja posvećuje najveća pozornost. Kako bi se realizirao projekt, za obradu video snimki primjenjena je trodimenzionalna kinematička analiza koja je omogućila neposredno izračunavanje ukupne brzine TT potkoljenice u zglobu koljena odskočne-doskočne noge, bacanjem rukometne lopte skok šutem: u dalj, sa otklonom (eret) i u vis. Cilj studije bio je da se na temelju dobivenih podataka o mehaničkim karakteristikama zgloba koljena i brzini centra težišta potkoljenice utvrdi moguća statistički značajna razlika u rezultanti brzina TT potkoljenice (VTbR) kod odskoka i doskoka, pri bacanju rukometne lopte skok šutem: u dalj, sa otklonom (eret) i u vis, koja će prevenciju povrede Anterior Cruciate Ligamenta podignuti na veću razinu. Na temelju rezultata istraživanja i postavljenih hipoteza dobivene su činjenice da u mehaničkim karakteristikama zgloba koljena i rezultanti brzina TT potkoljenice (VTbR) kod odskoka i doskoka, pri izvođenju sve tri vrste skok šuteva u rukometu postoje određene statistički značajne razlike. Statistički značajna razlika u ukupnoj brzini centara težišta potkoljenice utvrđena je pri bacanju rukometne lopte skok šutem: u dalj i vis i skok šutem: sa otklonom-eret i dalj, i kod odskoka i doskoka, dok statistički značajne razlike u rezultanti brzina TT potkolenice nije bilo pri izvođenju rukometnog skok šuta sa otklonom-eret i vis, također, i pri odskoku i doskoku.

Ključne riječi*: skok šutevi u rukometu, potkoljenica, prevencija ACL*

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