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Ita.J.Sports.Reh.Po.

Italian Journal of
Sports Rehabilitation and Posturology

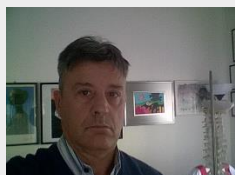


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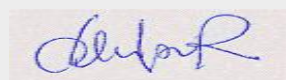


As Editor-In-Chief I want to welcome you to the Journal of Italian Journal of Sports Rehabilitation and Posturology In the last few years Rehabilitation and Traumatology Science applied to sports has passed gradually from empirical theories in the treatment and recovery of injured athletes to a significant enhancement of therapeutic strategies – thanks also to scientific contributions coming from all over the world. So a different approach to traumatology and rehabilitation as regards sports injuries has become possible thanks to the contribution of: a) a better understanding of the healing process of injuries and surgery techniques b) a more adequate understanding of the clinical biomechanical behavior c) postural strategies along with the studies and analysis of the gestural movement d) the different myo-osteoarticular structures in response to internal and external load. At present, most of the research highlights how important it is to treat injured athletes and to propose strategies and concepts based on an 'evidence-based approach'. So in a conceptual view of the rehabilitation of the injured athlete the therapist must choose those means and those strategies that reveal a clinic appropriateness, based on scientific data and aiming at an optimal return to sport.

The acquisition of new technologies for collecting clinical, physiological and rehabilitation parameters has allowed experts to improve their therapeutic abilities. The multidisciplinary treatment, now widely recognized by the scientific population, finds practical application difficulties because of the limited availability of rehabilitation specialists


Our editorial goal is to provide a tool for an adequate scientific update in the rehabilitation and sports posturology and to offer a modern, multidisciplinary point of view on traumatic injuries.


Kind Regards,




Rosario D'Onofrio,
Editor In Chief - Ita. J. of Sports Reh. Po.


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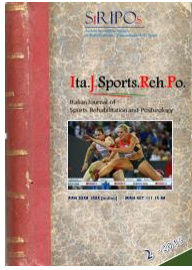
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Statistical epidemiological trends of injuries in European Handball. Retrospective analysis.

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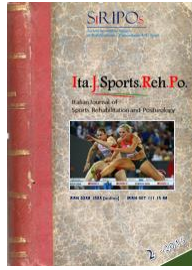
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Introduction

Handball is classified as a team sport, alternating aerobic-anaerobic, with a metabolic activity dependent mainly on the anaerobic-alactacid system.

During a match the athlete makes numerous changes of direction and pace, vertical jump shots or standing shots and shots while falling. We can see that: a) 73-75% of all shots in a match are made during a jump, b) 14-18% standing shooting while running (c) 6-9% penalty d) 2-4% shots while falling e) 0-1% direct free shots (40).

Recent studies have analyzed the gestural pattern of shots in handball teams, highlighting different expressive gestural techniques related to different ball velocity (41).



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Bayios and Boudolos (42) studied the differences in ball velocity and throwing accuracy among handball players in the Greek Elite Championship.

The author showed how a different ball velocity is also linked to specific gestures: a) shoot while running without jump (speed $26.3 \pm 3.2 \text{ m} \cdot \text{s}^{-1}$) b) shot without run nor jump (speed $23.5 \pm 2.2 \text{ m} \cdot \text{s}^{-1}$) c) jump shot (speed $22.7 \pm 2 \text{ m} \cdot \text{s}^{-1}$).

A complete kinematic analysis of the shot in a handball team (40, 41) showed that angular velocity of shoulder internal rotation to ball release, and maximum elbow extension are important contributors to ball velocity.

Contacts-contrasts occur with very high frequency in throwing. Hence it is clear that the risk of traumatic events affecting the osteomyoarticular system is high and unavoidable.

The aim of this work is to fathom the existing literature on handball injuries and give an overview of the most important international works, in order to identify the risk factors and the most frequent injuries during agonistic sport activity.

Epidemiological investigation in European Handball

Already in 1988 handball was subject to a study by Nielsen AB, Yde J., (2). The incidence of lesions found on 221 handball players, was 4.6/1000 training hours and 11.4/1000 hours game. Upper limb injuries were 41% of the total, among these 21% were linked to lesions of metacarpophalangeal.

Conversely Wedderkopp et al (43) in 1977 completed a retrospective study on Danish handball, and found that young female players had a much higher injury incidence, up to 41 injuries per 1000 hours game.

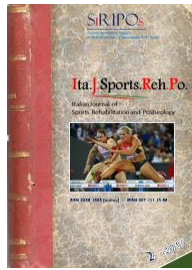
Injury rates among senior players are similar to those found in young players, 12 to 14 lesions per 1000 hours game (44).

Ankle sprain is the most common injury (17, 40, 43) 44, 45) with a percentage of 33%, while overuse injuries were around 18%.

Re-injury risk remained very high, as in other sports with jumping; it was found around a percentage of 32%. According to the authors, the main injury mechanism is the contact/contrast (Figure 1), and this is a game situation occurring mainly during the shot, which is known as overhead gesture (31% of lesions).

Injury risk in handball is substantial, this was confirmed by the International Olympic Committee (IOC) during the latest Summer Olympic Games. In their study Engebretsen et al (7) reported that 22% handball players got injured during the 2012 London Games (45).

Compared to other Olympic team sports, injuries appear to be much lower than soccer (35% of players injured in the Olympic tournament) but significantly higher than basketball (11%) and volleyball (6.9%).



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Figure 1 - Contrast - contact

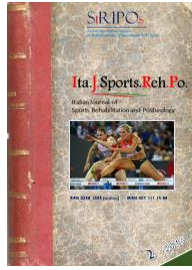
Hand-distorting events are mainly related to poor ball reception, falls on the court while performing acrobatics, or arm block by defenders in the throwing / passing phase.

Technical errors in ball catching are the primary injury mechanism for the majority of harmful events to metacarpophalangeal and interphalangeal joints.

After harmful events 73% of injured players are absent from training and matches for more than 2 weeks. 41% of handball players do not reach a satisfactory clinical and sports recovery, and have "complications" till the end of the season and beyond. 40% of the athletes use unprofessional cares and treatments.

A chronic damage of lumbosacral hinge was especially found in athletes over 28 years.

D'Onofrio R. et al 2010 (17), in an unpublished statistical work on the 2008/2009 championship in A1 Men Handball Division, studied a sample of 90 players, belonging to 6 teams.



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An epidemiological research (Table 1) showed how the upper limb is the segment most affected (43%) with inflammatory / degenerative diseases, caused by the repetitive technical act of throwing, which creates an over stress affecting the muscle-tendon system of the shoulder, especially the supraspinatus and the long head of the biceps brachii.

Genevois (34) today confirms this trend, pointing out that a muscle strengthening training program called "Suspension Training", 2 times a week for 6 weeks, is effective in improving muscle strength of shoulder external rotators and decrease this trend. Conversely, this preventive proposal causes a decrease of the articular range of motion in the shoulder internal rotation, while speed of movement, hence launch-speed, remains stable.

The author recommends integrating with a stretching program that could balance potential adverse effects on shoulder motion range. It is right to point out what was shown by Edouard (2013): in women's handball, muscle strength of shoulder's internal and external rotators is higher on dominant side (35). Clarsen B. advises to add measures to improve glenohumeral joint rotational range and, particularly, strength training of external rotator muscles, since their weakness, according to the author of this study, raises the risk of shoulder injuries.

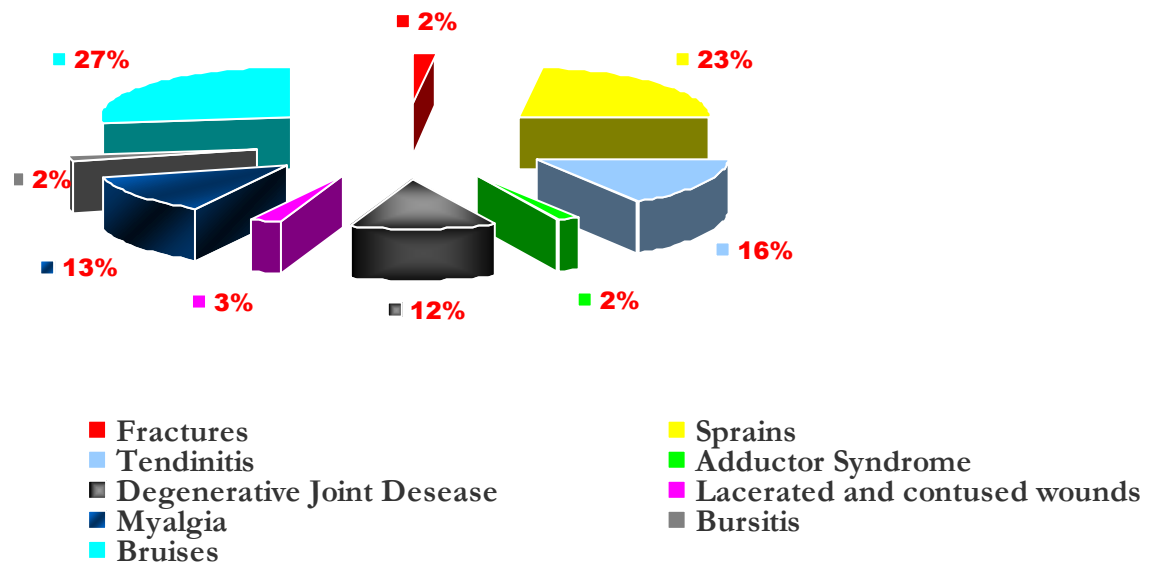
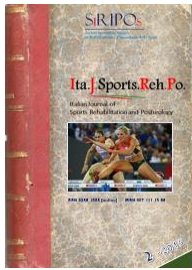


Table 1. Epidemiological presentation of injuries in 2008/2009 A1 Division Handball Championship.



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In lower limbs were found injuries from overuse, such as Jumpers Knee (43%). This relates to various court surfaces. (It is clear that the compliance of natural elastic court surfaces (parquet) are absorbent structures tending to minimize "kickback" trauma).

The authors have statistically found at the top of trauma pyramid in Italian handball, ankle- bruises and sprains (73% of all sprains) (table 1) with the highest peak reached during training (58%) (Table 2), without preventative taping.

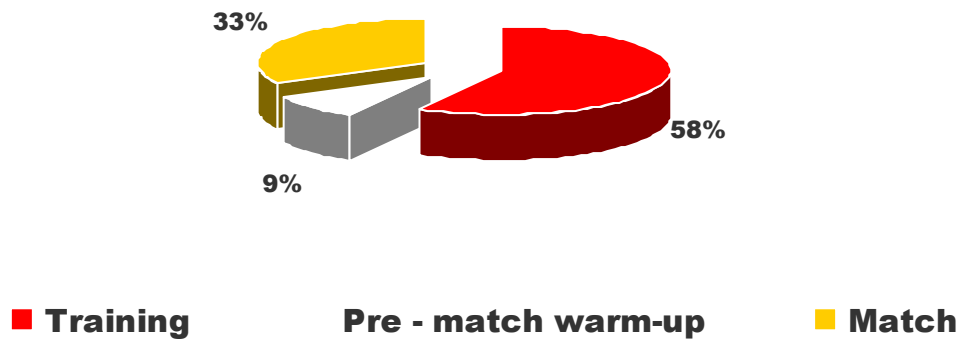
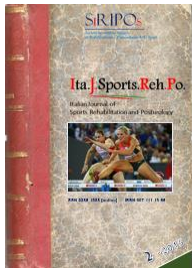


Table 2: Incidence of sprains during physical activity (D'Onofrio R. 2010)

In a study, Langevoort G points out the high incidence of lesions observed in Olympic tournaments and world championships, highlighting the great number of injuries occurred during matches. At the London Olympics, 75% of all the lesions occurred in matches and 25% in training (48), 45% occurred in the middle 10 minutes of both halves.

In Italian handball blunt traumas (Table 3) are statistically found in all players, regardless of the role they play. 48% regard the thigh, especially the quadriceps.

Quadriceps contusions occur during the various defensive systems, when impenetrable defense pushes the attackers to look for long shots or vertical jump shots from the line of 6-9 meters. This game model causes, especially during the landing, a contact between defender's thigh and attacker's knee with a consequential blunt event.



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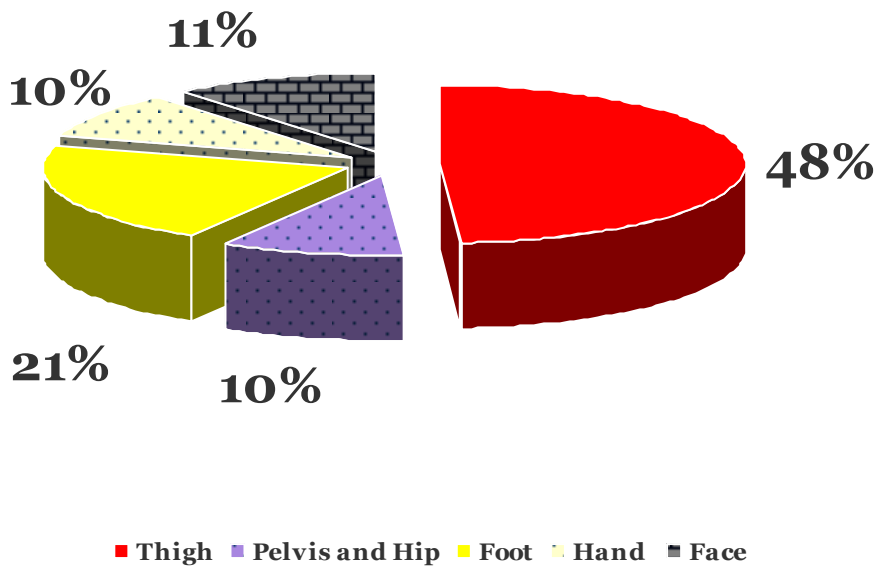
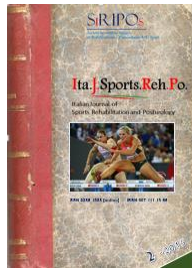


Table 3 - Blunt traumas in handball (D'Onofrio, R. 2010)

The functional rehabilitation program adopted to go back to competitive sport, does not differ from that of other sports with jumping and from the many available in the literature (19)
 It is clear that a functional treatment after ankle sprain protects proprioception, and highlights the often overlooked importance it has on neuromuscular control of a joint so crucial in handball.
 The study, carried out on players of a handball team in the A1 Division (17), showed that athletes who suffered ankle sprains during the championship, were those who, in the postural screening during the pre-season, had deficits in gastro soleus flexibility.
 A reduction in activity, in terms of flexibility and strength, of gastrocnemius and soleus may be a predisposing factor for further ankle injuries, and later compensatory upward postural changes.
 Regarding flexibility, Zakas A (22) states that 20 minutes of dynamic stretching exercises inserted in the warm-up before the match/ and training have a positive effect on flexibility and range of motion of lower limbs in junior handball players.
 It is known the importance of gastrocnemius and soleus muscle activity on the ankle, for example during squatting, one of the most frequently used closed kinetic chain exercises, to develop athletes' strength.



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The effort of gastrocnemius muscle increases with increasing knee flexion and decreases in extension (21).

The peak activity of gastrocnemius muscle is placed in a range between 60 ° and 90 ° of knee flexion (20).

A shortening of tibialis anterior can cause a decrease in plantar flexion, conversely tension of the gastrocnemius and soleus may contribute to excessive tension of tibialis anterior.

In this balancing act the normalization of joints and of muscle chains of the entire lower limb kinetic chain becomes very important.

Neuromuscular control of ankle joint is related to optimal muscle activity.

The literature suggests proprioceptive trainings aimed at stimulating a rapide muscle response, in order to improve their control when playing.

Leidinger A. et al. (3) reported a number of 540 lesions in 5 years of competitions, on 286 athletes of the German Handball Association (DHB).

For Lindblad et al (6) 62% of the lesions were associated with both sprains and strains of lower limbs, while 12% were fractures. The 68% of injured players were absent from competitions more than 1 week.

Other authors, such as Yde J, Nielsen AB. (5), in a perspective study on 302 young athletes practicing soccer, handball and basketball, found 119 injuries affecting the osteomyoarticular system. The injury incidence per 1000 playing hours was:

- 5.6 in soccer
- 4.1 in handball
- 3.0 in basketball.

Metacarpophalangeal distortions were 32% of all lesions, while those of the ankle approximately 25%.

Muscle injury of knee flexors and extensors account for 10% of total lesions; tendonitis and apophysitis for 12%.

Authors noted also: 4 fractures, 1 lesion of the anterior cruciate ligament, and 2 meniscal tears.

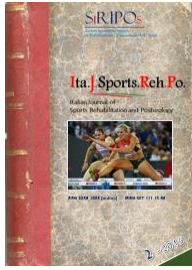
The epidemiological investigation highlights that in soccer most injuries are associated with contact-contrasts; on the contrary in handball and basketball, injuries during training and matches are not often caused by actions of contact-contrast but, as mentioned earlier, by different ways of running.

Wedderkopp N, Kalsoft M, et al. (15) aimed at examining nature, extent and severity of injuries in sport teams in European junior women's handball and identifying etiological factors contributing to injuries.

The study included twenty-two teams with 217 players, age range 16-18 years. They observed a very high incidence of injuries during matches, with 40,7 per cent per 1000 hours of play.

Back player was the role with the highest frequency of injuries (54.8 / 1000 hours of play).

Finally Seil R, Rupp S, et al, (8) tried to assess, in a retrospective screening, traumatic injuries in 186 male players from 16 handball teams. Injury percentage was 0.8 per 1000 training hours and 13.5 for 1000 match hours. Injuries were predominant in lower limbs, and ankle injuries were shown to be the most frequent lesions.



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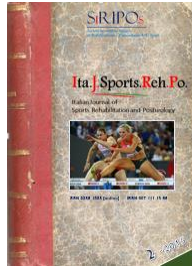
The 2/3 of the injuries occurred during offensive phases of the game, 1/3 of these injuries were counter-attack actions. Recently a work by Clarsen B. in 2014 (37) confirmed the retrospective trend, highlighting how in sports with jumping the knee is the most affected anatomical region, with an average incidence of lesions of 36% , together with the shoulder with 22%.

2) "Handball goalie's elbow"

One of the most characteristic injury in handball involves the elbow: "handball goalie's elbow." The goalkeeper's injury.
For Tyrdal S, Olsen BS. (9) the etiopathogenetic mechanism of "handball goalie's elbow" is linked to biomechanical aspects of the catching technical movement (Figure 2)



Figure 2 - Typical gestures of handball goalkeepers



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Hyperextension under load, due to violent contact with the ball, induces laxity of elbow joint, positioned for the catch around 50 degree flexion.

No instability is found in elbow flexion over 90 degrees.

Kinematic changes during ball impact are connected with a "*forced-valgus and internal-external axial rotation*".

For Tyrdal S, Pettersen OJ. (10) the clinical picture of "handball goalie's elbow" is characterized by a sharp elbow pain, becoming so disabling as to require stopping competitions for a long time.

To this end they tried to examine (10) the results of a strength training program in goalkeepers with "handball goalie's elbow", in preventing a disease so "rebel" to any treatment, and verify its effectiveness in reducing rehabilitation time.

The training protocol included concentric and eccentric exercises for upper limbs, under load of approximately 80% 1-RM with 8 to 10 repetitions to be performed three times a day, for 3 sessions per week.

Muscle strength was investigated, related to flexion and extension of elbow and wrist, and forearm pronation and supination.

The evaluation analysis involved 16 amateur goalkeepers (10 men and 6 women) with 25 "elbows" (12 right and 13 left), all with "handball goalie's elbow".

The average age of athletes surveyed was 21.0 years (range 16-35), and elbow's pain had an incubation period of 28.9 months (range 3-54). Players were tested both at the beginning of training and after 24 month work.

Strength tests were carried out and showed immediate improvement in all strength levels and a significant decrease in the clinical picture.

The study shows that specific strength training can be very effective in reducing rehabilitation time in goalkeepers with 'handball goalie's elbow'.

Another study on athletes with "handball goalie's elbow" is Tyrdal S, Bahr R. (14). In 1992, they sent a questionnaire to 449 senior coaches and 32 junior coaches of smaller teams in Norway.

Among these, 304 technicians answered, a percentage of 63%.

This pointed out that a total of 329 goalkeepers out of 729 ($45 \pm 1.8\%$) and 166 players out of 4120 ($4.0 \pm 0.3\%$), had experienced acute or chronic symptoms related to one or both elbows during their daily sports activities.

During a two-year observation period, from 1992 to 1994, $8.6 \pm 1.8\%$ of goalkeepers suffered elbow pain.

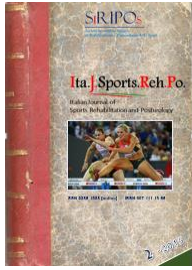
The article concludes that elbow pain and related functional deficits are a significant and extremely disabling problem for a large number of handball goalkeepers.

Popovic N, Ferrara MA, et al (11) also compared, on 40 players, events of mechanical valgus stress on elbow, due to repetitive loads given from ball contact coming at different speeds.

The evaluation was carried out through routine imaging instrument (Rx, ultrasound, and MRI).

Ultrasound showed a significant increase in thickness of: flexor - pronator tendon (0.56 ± 0.90 mm), of extensor tendon (± 0.96 to 0.50 mm), of triceps tendon (0.69 ± 0.27 mm), and of medial collateral ligament (0.47 ± 0.24 mm).

Values were systematically higher for the dominant upper limb.



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Ultrasound examination showed intra-articular effusion in 67% of players, and small periarticular calcification in 33.3%, exclusively in the dominant elbow.

This study shows that repetitive stress on upper limbs in handball goalkeepers is responsible for physiological and pathological changes in the elbow.

3) ACL injuries in handball

Body language in a handball match shows a series of very complex physical skills and techniques, such as changes in direction and speed, leaps, jumps, vertical jump shots and shots while falling. These cause different degrees of stress on knee joints, as well as on the rest of lower limbs (32).

Repetitiveness of technical movements in handball players induces traumatic lesions of central pivot of the knee and especially of the anterior cruciate ligament.

Its etiopathogenetic mechanism is mainly related to movements of cutting or landing after a jump, and in any case without direct contact with another player. (26)

Several studies have reported on the incidence of anterior cruciate ligament (ACL) injuries in handball. In a retrospective study, published in 1990, Strand et al (46) found that the incidence of ACL injuries was higher in women playing at top level with 0.82 ACL injuries per 1000 playing hours, compared to tennis players with 0,31 lesions per 1000 playing hours (46).

The highest incidence of ACL is found in elite female handball in Norway with 2.29 ACL injuries per 1000 match hours (47).

Olsen E, Engebretsen L. et al. for example, registered 32 traumatic ACL injuries during one handball season (1998-99).

Of these lesions, 24 (75%) occurred during a competition:

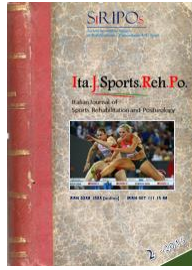
- 84% during offensive action
- 59% during cutting movements
- 19% in landing after a jump

In 63% of cases athletes reported ACL injury without any contact with an opponent.

In Italian championship, most ACL injuries are related to different ways of running, especially in sudden changes of direction.

Sideward movements, compared to running straight, especially before offensive penetrations, put a higher load on the knee because of varus-valgus movements, combined with internal and external rotation. (Figure 3)

Most anterior cruciate ligament injuries in European handball occur during the "side-step cutting maneuver." D'Onofrio R , Manzi V. et al. have recently described the "sidestep cutting maneuver" in a paper (33).



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Figure 3 – Cutting movements before penetration

It is a typical movement in basketball and handball, perhaps the first non-contact mechanism, by findings in the literature, which causes anterior cruciate ligament lesions. (33) It is performed in a small space, both in ball possession and not, with a range of 25-45 degrees of knee flexion (33). Players perform dynamic action force (initial, explosive), whose activation and interval times are not stereotyped, but given by countless technical tactical situations that affect its performance and intensity.

If the anterior cruciate ligament gets injured during a "sidestep cutting maneuver", the etiopathogenesis, among others possible, is often linked to a deficiency in neuromuscular control, that is the athlete's loss of ability to control the internal tibial rotation of the knee. (33)

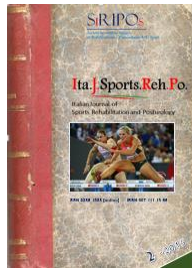
It was suggested that the gastrocnemius muscle increases stability of knee joint, especially regarding tibial rotations (18), so it is possible to link ankle instability to inhibition of gastrosoleus activity, which would later be a predisposing factor for ACL injuries.

For Petersen W, (23) it is possible to reduce the incidence of lower limbs injuries. A handball team (2nd league) carried out a proprioceptive neuromuscular training both during the preseason and the regular season.

The program consisted of:

1. Information on injury mechanisms
2. Proprioceptive training (balance-board exercises)
3. Jump training.

Another handball team, control, did not do any preventive training.



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Compared to the previous year, taken as statistical control, no player taking part in the proprioceptive training / prevention group had ankle or knee injuries.

A recent study shows that proprioceptive and strength training included in daily workouts, help to significantly reduce number of capsular ligament injuries to ankles and knees. (25)

In women handball, ACL injuries are much more common than in men.

The literature seems to agree in identifying hormonal fluctuations, creating changes in women's neuromuscular system and myo-tendon system, a clear predisposing factor in raising the number of anterior cruciate ligament ruptures in female players.

Specifically female athletes show a decrease of joint stiffness, associated with neuromuscular problems, and relative instability of knee joint.

Therefore, the resulting knee instability causes in female athletes a higher deficit of neuromuscular control with an important injury risk increase.

Most anterior cruciate ligament lesions occurred during the ovulatory phase, period with high estrogen concentration, associated with a decrease in strength and proprioception levels (29, 31)

It also appears that during the ovulatory phase, marked by high estrogen concentration, female players have a reduced performance, referred also to spatial representation's work.

Values for muscle strength are greater in post-menstrual and post-ovulatory phases. (31) In pre-menstrual and menstrual phases they show a decrease in aerobic endurance.

On the contrary post-menstrual and post-ovulatory phases are characterized by greater mobility with a relative increase in flexibility and a higher neuromuscular activity. (31) Conversely fewer injuries, in descending order, occurred in the follicular phase.

Using oral contraceptives helps to stabilize period and lower ACL injury risk. (29, 30, 31)

Myklebust G et al (27) in a study carried out in 2003 on 2647 female players participating in the top three divisions in Norway has shown that it is possible to reduce the incidence of ACL injuries in female handball through a five phase neuromuscular training of at least 15 minutes.

Reckling C (28) in a recent study on junior handball teams showed 130 lesions in 73 players out of 100 (50 men and 50 women). 73% occurred between 15 and 16 years, with 69% during offensive game actions. Women goalkeepers turned out 3 times more subject to injuries than their male colleagues of the same age.

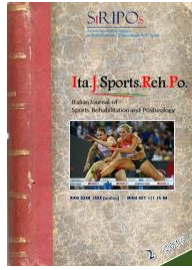
The most typical game situation found was: when receiving the ball (38.5%), contact with an opponent (34.5%), and landing after a jump (26.2%). Knee joint counted 24.6% lesions of surgical interest. The main lesion was ACL rupture.

Lesions were recorded according to athletes' age:

- no. 11 among 15-18 years
- no. 1 among 12-14 years
- none among 8-12 years

Authors show that it is possible to prevent and reduce the incidence of injuries in youth leagues through a specific training aimed at improving coordination, combined with a careful development of muscle strength, especially in the age 15-18 years.

Proprioceptive protocols are then encouraged, and so are exercises designed to "clean up game technique", and specific jumping and landing techniques.



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Myklebust G, et al (12) examined differences in the incidence of ACL injuries in a population of top level handball team players. They reported also injury mechanisms and possible risk factors, related among other things to women's menstrual status.

The study was performed during the seasons 1993-94, 1994-95, and 1995-96. 28 ACL injuries were found: 23 among women and 5 among men.

Of the 28 lesions, 24 occurred during a match and 4 during training.

Almost all lesions (n = 25) occurred in non-contact situations, when players carried out torsional-lateral-and rotator combined movements, associated with complex gestural patterns.

A "menstrual story" could be the cause in 17 out of 23 ACL injury cases among women. 5 injuries happened just in the menstrual phase, 2 in the follicular phase, 1 in the early luteal phase and 9 in the late luteal phase.

Results suggest that it is worth considering an increase in ACL injury percentage risk during the week before or just after the start of menstruation.

Finally, we want to emphasize that in handball, as in other sports, muscle fatigue was associated with a percentage increase of anterior cruciate ligament (ACL) injury risk.

In a study Zebis MK (39) through game simulations and more precisely during side-cutting maneuvers, at the end of the training pointed out a significant decrease of the MVC force for the Quadriceps and Hamstring muscles

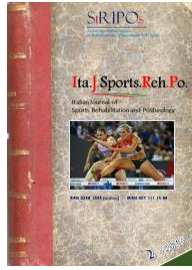
In order to decrease ACL injury rate in handball, Michaelidis M (38), in a 2014 work, verified that a combination of balance-strength-plyometric training can give interesting results in a significant reduction of knee's capsular ligament injuries.

Conclusion

From this review on European handball, we can conclude that handball goalie's elbow is the valgus-force repetitive stress injury characterizing the role of handball goalkeeper, and it is the most disabling injury as far as sport performance is concerned.

Handball is an overhead sport that gives supra-physiological stress, therefore a prominent place in the injury pyramid have overuse injuries and tendinitis or tendinosis of Achilles tendon, patellar tendon, supraspinatus, long head of the biceps brachii.

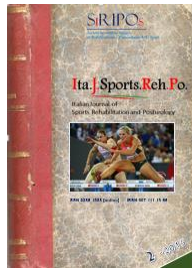
We do not have to forget the repetition of technical movements, which concur in increasing risk factors, as do mistakes in the training programme and early resumption of sports activity after a rehabilitation phase.



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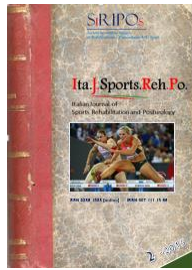
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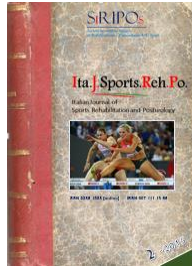
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