THE ROLE OF PROPRIOCEPTIVE TRAINING IN THE PREVENTION OF KNEE LIGAMENT INJURIES

Ph.D. theses

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**Introduction**

27-50% of all sports injuries affect the lower extremity. Knee injuries are responsible about 13% of all injuries, and are the second most common injury (25%) location after ankle injuries 40% of the lower extremity.

Futsal, wrestling and handball have the highest incidence of knee injuries. The most serious problems among sports related knee injuries are the ligament injuries, because these structures are responsible for the stabilization of the joint. More serious forms can reduce the one’s daily activity, and could lead to irreversible joint degeneration.

Van Mechelen’s sequence of prevention for the development of effective prevention methods served as guideline for my dissertation, which intended to prove the preventive effect, but first and foremost the mechanism of this preventive effect of the neuromuscular or neurofacilitation training. This method is often referred to as proprioceptive training, without its proprioceptive effect being ever proven.

According the first step of the prevention sequence, the incidence and severity of knee injuries has to be explored in the population at risk. So I defined the severity of sport injuries of the knee joint at the Sportssurgery Department of
the National Institute of Sportsmedicine (NISM) between 1991-2003, than I defined also the incidence of knee injuries in two team sports. 

In conformity to the second step of van Mechelen’s sequence it can be stated, that the mechanism of the injury and its relation to proprioception is already well described. Based on those studies, complex training programs were developed intending to improve proprioception. While positive effect of the training on injury incidence is already proven by many authors, a direct proprioceptive effect could not yet be proven. As the third step of the sequence to answer the question, whether this special physiotherapeutic method really improves proprioception, I investigated its effect on joint position sense. In a group of female handball players, we implemented these neurofacilitation exercises in their daily training program, and we measured their joint position sense in the knee joint before and one year after the intervention. By doing so, I intended to prove the proprioceptive mechanism of the preventive effect. 

Of course I also controlled the preventive effect by means of epidemiological methods, although this way the preventive effect was already proven by other authors.
Aims

1. To define the epidemiology of knee injuries among the inpatients at the Sportssurgery Department of the NISM.
2. To examine the injury pattern of in team handball and football prospectively
3. To develop a education material to prevent knee injuries, and make it available for athletes.
4. To define the effect of proprioceptive training on joint position sense in the knee joint.

Methods

*Evaluation of the epidemiology of knee injuries*

First, I examined the knee injuries among inpatients of the Sportssurgery Department between 1991-2003. The names of the elite level athletes were registered monthly by one of the physician, on this way their documentation were accessible. For the evaluation I established a questionnaire at the beginning of the survey.

I evaluated two population prospectively, the students of the first Hungarian football academy, and the players of elite
female handball teams. We recorded the exposition and the circumstances of injuries on specially designed questionnaire.

**Evaluation of the sensory function of the knee joint**

Players of two elite handball teams took part in the evaluation. The intervention group made up of 20 athletes, the control group consists of 19 players. For the measurements we use a twin axis goniometer (XM180, Biometrics Ltd) and JPS 4 technique. During testing learning effect and visual control related to the boxes were eliminated. In a 10-80° flexion angle range we established three intervals within a subject should perform 5 estimations each. One subject’s above described examination provided for each knee 15. We measured joint position sense at the beginning and at the end of the intervention at both group, we performed an additional evaluation at the intervention group. The neurofacilitation training what we applied at the intervention group was similar to those described in the literature. Statistical calculations were made with the help of the Statistica 6.0 software using non-parametric tests based on mean absolute estimate errors.
Results

*Evaluation of the epidemiology of knee injuries*

223 elite athletes’ knee injuries were treated at the Department of Sportssurgery of NISM between 1991-2001. Mean age was 22.63 years, 63.2% were male patient. The vast majority of the patients were football player. (Table 1)

<table>
<thead>
<tr>
<th>Sport</th>
<th>Sum</th>
<th>%</th>
<th>Knee injured</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>110</td>
<td>27%</td>
<td>60</td>
<td>27%</td>
</tr>
<tr>
<td>Handball</td>
<td>44</td>
<td>11%</td>
<td>30</td>
<td>13%</td>
</tr>
<tr>
<td>Track &amp;Field</td>
<td>38</td>
<td>9%</td>
<td>15</td>
<td>7%</td>
</tr>
<tr>
<td>Wrestling</td>
<td>31</td>
<td>8%</td>
<td>19</td>
<td>9%</td>
</tr>
<tr>
<td>Basketball</td>
<td>26</td>
<td>6%</td>
<td>15</td>
<td>7%</td>
</tr>
<tr>
<td>Volleyball</td>
<td>17</td>
<td>4%</td>
<td>11</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 1.

The institute has 1147 athletes (867 male, 280 female) inpatients’ knees were treated between 2001 and 2003. The patients showed the following distribution: 65 elite athletes, 459 certified athletes, 623 hobby athletes. The majority of injuries were ACL rupture. (Table 2.)
Table 2.

78 adolescent players attended the Football Academy Sándor Károly in 2006-2007 seasons. The incidence of injuries was 2.85/1000 exposition hours. One player suffers an average 3.29 injuries a season. We registered all together 257 injuries. A player missed 10.88 days from football.

Table 3 shows the distribution of injuries.
<table>
<thead>
<tr>
<th>Type of injury</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle lesion</td>
<td>135</td>
<td>53%</td>
</tr>
<tr>
<td>Ligament lesion</td>
<td>75</td>
<td>29%</td>
</tr>
<tr>
<td>Contusion</td>
<td>32</td>
<td>12%</td>
</tr>
<tr>
<td>Lowback pain</td>
<td>5</td>
<td>2%</td>
</tr>
<tr>
<td>Distorsion</td>
<td>4</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of injury</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thigh</td>
<td>135</td>
<td>53%</td>
</tr>
<tr>
<td>Ankle</td>
<td>49</td>
<td>19%</td>
</tr>
<tr>
<td>Knee</td>
<td>33</td>
<td>13%</td>
</tr>
<tr>
<td>Lower leg</td>
<td>16</td>
<td>6%</td>
</tr>
<tr>
<td>Foot</td>
<td>15</td>
<td>6%</td>
</tr>
<tr>
<td>Lower back</td>
<td>5</td>
<td>2%</td>
</tr>
<tr>
<td>Shoulder</td>
<td>4</td>
<td>2%</td>
</tr>
</tbody>
</table>

Evaluation of the proprioceptive sensory function of the knee joint

The incidence of injuries was 0,74/1000 hours (2,86/1000 match hours, 0,48/1000 training hours) in the
intervention group, and 1,11/1000 hours in the control group.

**Results of the control group**

The mean absolute estimate error was at the beginning of the evaluation 6,73°±5,25° which did not differ significantly after one year time (6,29°±5,73°).

**Results of the intervention group**

The mean absolute estimate error of the intervention team at the baseline was 9,00°±6,14° which decreased significantly after 4 months of intervention 4,00°±3,48°, but there was no further improvement in the joint position sense in one year time(3,82°±3,58°). (Figure 1.)
Conclusion

Following van Mechelen’s sequence I established an algorithm to prevent knee ligament injuries among athletes.

1) With the established questionnaires:
   a) I determined the epidemiology of knee injuries of athlete at the NISSL Sportssurgery Department between 1991-2003
      i) Average age of the athletes at injury.
      ii) The dominance of male athletes in knee injuries.
      iii) The vast majority of athletes were football player.
      iv) The most frequent operatively treated diagnose.
v) The most frequent type of operation procedure.

b) I determined the established register is suitable to follow the impatient athletes prospectively.

2) I defined with a prospective evaluation:
   a) the incidence of injuries in female handball which is similar to the data already published in the literature
   b) the epidemiology of injuries at the first Hungarian football academy between 2006 and 2007, which was similar to the data published in the literature.

3) I created two injury prevention educational DVD, which are available for athletes.

4) As a result of the evaluation of the sensory effect of the proprioception training:
   a) I defined that the proprioceptive training reduces the injury incidence of the lower extremity, and improve the joint position sense of the knee joint. According to these findings the proprioceptive training is recommendable in the field of prevention as well.
   b) I defined that the joint position sense improved significantly after 4 months in the intervention group in both knees. I defined that after 4 months we could not observe any more improvement in the joint position sense in the intervention group.
Suggestions

- According to my findings I suggest the use of my sports injury register at departments which treat musculoskeletal disorders of athletes.
- I suggest the use my register - which was created according to UEFA and FIFA disciplines – at football academies to register football related injuries.
- I suggest the use my handball injury-register to record sport exposition and the circumstances of injuries.
- I suggest the implementation of the proprioceptive training in a preventive manner, in all pivoting sports, especially where the rate of non-contact injuries is high.

List of publications

In conjunction with the thesis
As first author:


As co-author:


Not in conjunction with the thesis

As first author:


As co-author: