Dupuytren disease is highly prevalent in male field hockey players aged over 60 years

Dieuwke C. Broekstra, MSc
Edwin R. van den Heuvel, PhD
Rosanne Lanting, MD, PhD
Tom Harder, MD
Inge Smits, MD
Paul M.N. Werker, MD, PhD

ABSTRACT

Background
Dupuytren disease is a fibroproliferative hand condition. The role of exposure to vibration as risk factor has been studied with contradicting results. As field hockey is expected to be a strong source of hand-arm vibration, we hypothesized that long-term exposure to field hockey is associated with Dupuytren disease.

Methods
In this cross-sectional study, the hands of 169 male field hockey players (IQR: 65 – 71 years) and 156 male controls (IQR: 59 – 71 years) were examined for signs of Dupuytren disease. Details about their age, lifestyle factors, medical history, employment history and leisure activities were gathered. Prior to the analyses, the groups were balanced in risk factors using propensity score matching. The association between field hockey and Dupuytren disease was determined using a subject specific generalized linear mixed model with a binomial distribution and logit link function (matched pairs analysis).

Results
Dupuytren disease was observed in 51.7% of the field hockey players, and in 13.8% of the controls. Field hockey playing as dichotomous variable after propensity score matching, was associated with Dupuytren disease (OR [95% CI] = 9.42 [3.01 ; 29.53]), but a linear dose-response effect of field hockey (hours/week * years) within the field hockey players could not be demonstrated (OR [95% CI] = 1.03 [0.68 ; 1.56].

Conclusion
We found that field hockey playing has a strong association with the presence of Dupuytren disease. Clinicians in sports medicine should be alert to this less common diagnosis in this sport.
INTRODUCTION

Dupuytren disease is a chronic hand condition, characterized by fibroblasts of the palmar fascia that transform into myofibroblasts, proliferate, deposit matrix and form nodules. Later on, cords are formed that may contract, causing flexion contractures of the fingers. In the general elderly population, the prevalence of this disease ranges from 0.6 to 31.6%. Several intrinsic risk factors have been associated with Dupuytren disease, such as genes, age, and male gender. Various extrinsic risk factors, such as alcohol consumption and vibration exposure have been associated to Dupuytren disease as well. Vibration exposure to the hands due to the handling of vibration tools for instance, can cause microtrauma and peripheral vascular changes. These two mechanisms are suggested to be involved in the pathogenesis of Dupuytren disease.

In the last decades, two literature reviews were conducted to elucidate the association between Dupuytren disease and vibration. Liss and Stock concluded that there is a strong indication for the presence of this association. Recently, a meta-analysis demonstrated that vibration was significantly associated with Dupuytren disease. Both reviews suggest that there is evidence for a dose-response relationship, but many included papers suffered from methodological flaws (e.g. unjustified corrections for factors that are no confounders, no physical examination to diagnose Dupuytren disease, inconsistencies in cross tabs possibly leading to an overestimated effect size). So, the reviews are inconclusive and more directed research towards vibration is needed.

Most studies investigating this association take only the vibration exposure during work-related activities into account. However, vibration exposure can also occur during leisure activities (e.g. sculpturing, do it yourself activities) and sports (e.g. tennis, baseball, golf). If vibration exposure during these kind of activities is associated with the presence of Dupuytren disease, this needs to be assessed when studying the influence of vibration to the occurrence of Dupuytren disease.

There is only one previous paper that reports a high prevalence of Dupuytren disease in sportsmen. However, this study focuses on the repetitive strain to the palmar fascia, and not on the vibration exposure. Sports such as field hockey, can result in vibrations with large amplitudes, especially when impacts are not located on the sweet spot of the stick. Therefore, we expected that there might...
be an association between field hockey and Dupuytren disease. Furthermore, we assumed that the majority of the field hockey players are white collar workers in the Netherlands. Therefore, this population is suitable to investigate vibration exposure, since it is unlikely that the possible effect of vibration through hockey will be confounded by an effect of manual work. The aim of the current study was to determine whether field hockey is associated with the presence of Dupuytren disease in elderly male field hockey players. We hypothesized that this association is present, and that a dose-response relation exists.

METHODS

Design
The hypothesis was tested by a cross-sectional study, including a group of field hockey players and a control group.

Participants
We performed a sample size calculation in G*Power version 3.1.2,26 using an odds ratio (OR) of 2.36 for vibration and manual work in association with Dupuytren disease15 and a proportion of Dupuytren disease equal to 0.22.5 To obtain a power of 80% for a two-sided test with the significance level at 5%, 74 participants were needed in each group (hockey players vs. controls) for a two-sample X²-test.

The hockey players were recruited from a field hockey club for elderly male field hockey players, most of whom have played at a high level for a long period of time. The measurements took place during a tournament, so all 204 elderly male field hockey players who were registered for the tournament were asked to participate in this study. The controls consisted of 250 males from an age-stratified random sample of the general elderly population of the city of Groningen, the Netherlands, that was drawn from the municipal administration. These participants were previously included in a prevalence study,5 and agreed to be approached again for further research. To control for the confounding effect of manual work, all manual workers were excluded, as well as all controls who were exposed to vibration during occupational, leisure or sports activities.

All participants gave a written informed consent. Due to the nature of this study, no approval of the medical ethics committee was needed.
**Procedure**

Prior to the start of the study, we asked the board of the field hockey club for permission to approach their members. After that, the field hockey players received an email with information about this study. On May 16th, 2013, the measurements took place during a tournament. Before the start, the field hockey players were reminded of this study using a presentation.

All participating field hockey players were interviewed about their employment history, leisure activities, lifestyle factors, health, and demographics. These interviews were conducted by employees of the department of Plastic Surgery, who received training beforehand on how to perform the interview, to ensure that all participants were interviewed the same way. After the interview, the hands of the participants were examined for signs of Dupuytren disease by medical doctors (RL and PMNW) with broad experience in diagnosing Dupuytren disease.

The same data was collected from the controls. Diagnosis of Dupuytren disease in the control group was already determined using physical examination in the study of Lanting et al. using the same criteria, but controls were contacted again by telephone to collect detailed information about their employment history, leisure activities, lifestyle factors and other missing information.

**Outcome measures**

The primary outcome measure was the presence of Dupuytren disease in one or both hands, defined as nodules or cords with or without flexion contractures of the fingers. The severity of the disease was a secondary outcome measure and determined using an adapted version of the Iselin classification (Figure 1).

We collected age, smoking habits, and alcohol consumption as additional measures, including the amounts consumed represented by cigarettes, cigars or pipes per day or by glasses per week, respectively. All participants were also asked about their general health, including diabetes, epilepsy, and whether they had sustained hand injuries in the past. The hockey players were asked about the intensity (hours/week) and duration (years) of the field hockey, during their life.
Dupuytren disease is highly prevalent in male field hockey players aged over 60 years.

**Statistical analyses**

Descriptive statistics were presented by frequencies and percentages for nominal and ordinal data. For data at interval or ratio level, descriptives were presented by medians and interquartile ranges (IQR). Differences between the hockey players and controls were determined by the Fisher’s exact test for nominal and ordinal data, and by the Mann-Whitney U test for data at interval or ratio level.

Since we expected the two groups to be significantly different on various characteristics, we used propensity score matching to balance the groups. A propensity score can be considered as an a priori probability of a participant to be included in the experimental group, in this case the field hockey group, given a set of characteristics. By matching the participants based on the propensity score, we
matched field hockey players with controls having the same likelihood to be part of the hockey group. The propensity score was calculated using a logistic regression model based on the variables age, diabetes, smoking, alcohol consumption and familial presence of Dupuytren disease. Epilepsy was not included, since only one participant suffered from this disease. Then, propensity score matching with replacement was done, with exact match priority. We used a caliper of 0.2 SD of the logit score as tolerance level for matching. When multiple controls were equally eligible to be matched to a field hockey player, the participant to be matched was chosen randomly. To determine whether the matching procedure successfully balanced the two groups in descriptive characteristics, we did the same statistical comparisons as mentioned in the paragraph above.

A subject specific generalized linear mixed model was fitted to determine the effect of field hockey as dichotomous variable on the proportion of Dupuytren disease. A Bernoulli distribution with a logit link function was used. We entered hockey (yes/no) as fixed effect, and a random effect for matched pairs to control for the correlated observations (resulting from the matching procedure).

Then, to examine the presence of a dose-response relation, we applied logistic regression within the field hockey group of the original (non-matched) database, with field hockey entered as continuous variable. This variable was standardized to the absolute number of weeks that a participants had played (hrs/week * yrs) / 168. Age was included in the model to account for its potential confounding effect. Additionally, we did an ordinal logistic regression analysis to determine the effect of field hockey on the severity of the disease, defined by the Iselin stage. A sensitivity analysis was done to gain more insight in the effect of field hockey on the presence of Dupuytren disease.

The propensity matching procedure and analyses were performed in SPSS version 23. Missing values were excluded listwise from the analyses, and a significance level of 5% was used.

**RESULTS**

A total of 325 subjects participated in this study. Among the field hockey players, 169 of the 204 hockey players who were asked for participation, agreed to participate (83%). In the control group this was 156 of the 247 (63%). Three of the 91 non-
Dupuytren disease is highly prevalent in male field hockey players aged over 60 years.

Figure 2. Schematic representation of the inclusion and exclusion procedure.

Participating controls replied that they refused to participate, the other 88 did not respond. In the full set of 325 participants, 24 of the 169 field hockey players (14%) were manual workers, compared to 67 of the 156 controls (43%). This difference was statistically significant ($X^2 = 33.3, p < 0.001$). We excluded manual workers and controls exposed to vibration (Figure 2). The propensity score matching procedure yielded 42 pairs, so the data of 84 participants in total were used in the analyses.

Table 1 shows the descriptive statistics of the field hockey players and the controls before and after the propensity score matching. Before matching, there were significant differences between the two groups with respect to age and smoking habits. After the matching, differences in characteristics reduced or vanished.
Table 1. Characteristics of the field hockey players and the controls before and after the propensity score matching procedure.

<table>
<thead>
<tr>
<th></th>
<th>Before propensity score matching</th>
<th>After propensity score matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hockey players (n = 145)</td>
<td>Controls (n = 58)</td>
</tr>
<tr>
<td>Age in years (median)</td>
<td>67.0</td>
<td>61.5</td>
</tr>
<tr>
<td>IQR</td>
<td>65.0 – 71.0</td>
<td>58.3 – 68.3</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Alcohol consumption in units/week (median)</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>IQR</td>
<td>5.0 – 20.0</td>
<td>0.2 – 11.3</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Smoking in pack years (median)</td>
<td>2.5</td>
<td>6.4</td>
</tr>
<tr>
<td>IQR</td>
<td>0.0 – 13.0</td>
<td>0.0 – 23.0</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Diabetes (n)</td>
<td>11 (7.6%)</td>
<td>5 (8.6%)</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Epilepsy (n)</td>
<td>0 (0.0%)</td>
<td>1 (1.7%)</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*a Mann-Whitney U test; b Fisher’s exact test, IQR = Interquartile range.
Table 2 shows the proportion of Dupuytren disease in the two groups, as well as the severity of the disease. Dupuytren disease was almost 4 times more prevalent in the field hockey group compared to the controls. In both groups, mild disease (i.e. nodules in absence of contractures) was the most common disease presentation. Only a few participants in both groups showed Dupuytren disease with flexion contractures of the finger(s).

Table 2. Proportion of Dupuytren cases and disease severity in the field hockey group compared to the control group.

<table>
<thead>
<tr>
<th></th>
<th>Hockey players (n = 145)</th>
<th>Controls (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dupuytren (n)</td>
<td>75 (51.7%)</td>
<td>8 (13.8%)</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Iselin stage (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>63 (43.4%)</td>
<td>5 (8.6%)</td>
</tr>
<tr>
<td>II</td>
<td>5 (3.4%)</td>
<td>1 (1.7%)</td>
</tr>
<tr>
<td>III</td>
<td>6 (4.1%)</td>
<td>2 (3.4%)</td>
</tr>
<tr>
<td>IV</td>
<td>1 (0.7%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

To visualize the proportion Dupuytren disease with respect to the amount of field hockey exposure, we plotted the logit of the proportion Dupuytren against different groups of field hockey exposure (Figure 3). It can be seen that the logit of the proportion Dupuytren disease was much lower in the control group compared to the field hockey players.

The results of the generalized linear mixed model after propensity score matching indeed show that field hockey playing as dichotomous variable was significantly associated with the presence of Dupuytren disease (OR [95% CI] = 9.42 [3.01 ; 29.53]).

Within the field hockey group, Figure 3 demonstrates that the highly exposed groups had a higher logit of the proportion Dupuytren disease than the lower exposed groups. This indicates the possibility of a dose-response relation. However, applying logistic regression within the field hockey group showed that field hockey as continuous variable (expressed as (hrs/wk * yrs)/168), corrected for age, did not demonstrate a significant dose-response relation with Dupuytren disease.

85
Dupuytren disease is highly prevalent in male field hockey players aged over 60 years (OR [95% CI] = 1.03 [0.68 ; 1.56]). The same result was found when the disease severity (Iselin stage) was used as outcome variable (OR [95% CI] = 1.00 [0.67 ; 1.49]).

We did a sensitivity analysis to determine if the choice of the model (linear profile for field hockey and the log odds for Dupuytren disease) would affect the conclusion. Two additional analyses were provided. We tried different cut-off points for the amount of field hockey to see if field hockey beyond the cut-off point would entail a higher proportion of Dupuytren disease. The optimal cut-off point was determined at 217 hrs/wk * yrs, and provided a p-value of 0.059. The second analysis tested a shift in distribution of field hockey between participants with and without Dupuytren disease using a Mann-Whitney U test (p = 0.433). Both analyses did not demonstrate a dose-response relation either.

Figure 3. The effect of field hockey on the logit of the proportion of Dupuytren disease.
DISCUSSION

After propensity score matching, our main result shows that field hockey has a strong association with Dupuytren disease. This extends previous findings of vibration being associated with Dupuytren disease in the occupational setting.\textsuperscript{8-10} We did not find a continuous dose-response relation within the field hockey group. This seems to be in contrast to several other studies that report a linear dose-response relation between vibration and Dupuytren disease.\textsuperscript{8,16,17}

\textit{Why no dose-response relation?}

There are several possible explanations that may account for this discrepancy. Previous reported studies may have overestimated the effect due to methodological issues, e.g. no physical examination to diagnose Dupuytren disease, or inconsistencies in cross tabs possibly resulting in an incorrect OR calculation.\textsuperscript{8,17}

Further, we drew our sample among elderly field hockey players who were still playing. Therefore, severe cases of Dupuytren with large hockey exposure might not have entered our sample due to the sampling procedure, as patients with severe disease would not be able to play anymore. Another possibility is that hand injury, that might result from playing field hockey, contributes to the larger proportion of Dupuytren disease in the field hockey group, but not to a dose-response relation. Hand injury has previously been associated with Dupuytren disease,\textsuperscript{5,34-36} and field hockey players might have a higher probability of injury as a consequence of the sport. We did inquire about hand injury to address this, but most participants had difficulties to remember the type of injury, and which hand or finger was injured. Thus we could not evaluate this hypothesis any further.

The results of this study suggest that the onset of Dupuytren disease may be triggered by playing field hockey, and that it does not influence the disease course. One theory is that mechanical stress (of field hockey) produces microtrauma, that may trigger the Wnt-signaling pathway, which is involved in cell proliferation and differentiation.\textsuperscript{37} By activating this pathway through mechanotransduction,\textsuperscript{38} proliferation of fibroblasts occurs. This theory is supported by the findings that the anomalies in Dupuytren tissue resemble the early stages of wound repair.\textsuperscript{36,39} This would support our findings of an effect of field hockey with the absence of a dose-response relation.
**Strengths and limitations**

The strength of this study is that all the participants were physically examined by medical doctors experienced in diagnosing Dupuytren disease. An inter-observer agreement study indicate that experienced observers reach an agreement of 95 to 100% for diagnosing the disease.40 This guaranteed the reliability of our observations. Another strength is the use of propensity score matching. In observational studies like this, randomization is not possible. Therefore, several sources of bias are introduced that can result in incorrect conclusions.28 After matching, the differences between the two groups were reduced or vanished, indicating that the propensity score matching provided a more balanced view on the characteristics between the field hockey players and controls. Additionally, by excluding all manual workers, we had a relatively homogeneous group of participants who were all exposed to vibration in the same way. This further extends the reliability of our results. Finally, using a sensitivity analysis, we tested whether we chose the correct model to evaluate the association. This was not significant, so we can assure that there is no dose-response relation between field hockey and the presence of Dupuytren disease in our sample.

There are several limitations in our study. First, recall bias was probably present in our study, since many variables were gathered using an interview. Unfortunately, there are no alternatives to determine, for instance, the life-time exposure to vibration as in field hockey. Second, the sample size calculation showed that we needed 74 participants in each group, while we had 42 participants in each group after matching. However, this sample size calculation was done for a two-sample X²-test and not for matched samples. The propensity score matching increased our effect size compared to an analysis without correction. Third, it is likely that the surface on which the field hockey players have played, and the material of which the sticks have been manufactured, can have large influences on the biomechanics of a field hockey shot. We did not gather this kind of information, so it might be that the lack of a dose-response relation can be explained by this. Finally, we probably missed severe cases due to the sample selection, since hockey players with severe Dupuytren disease may not be able to play anymore. Missing severe cases has probably resulted in an underestimation of the effect size in our sample. Although we examined 83% of the hockey players, it might be that those who did
not participate were not affected and therefore, did not feel the need to participate. However, by emphasizing the importance of participation before the start of the tournament, especially if the players were thought to be unaffected, we tried to limit the selection bias. Unfortunately, selection bias can never be ruled out in observational studies like this.

CONCLUSION

We found that field hockey playing has a strong association with the presence of Dupuytren disease. Clinicians in sports medicine should be alert to this less common diagnosis in this sport.

ACKNOWLEDGEMENTS

The authors would like to thank the players of the tournament of field hockey club ‘De Zestigplussers’ for their cooperation. We thank Sophie Post, MD, Evert-Jan ten Dam, MD, Joep Willemsen, MD, Sanne Molenkamp, MD, Edo Bramer, MD, and Jill van Meegdenburg, MD, for assisting in the data collection process.
REFERENCES


23. Russell DA. Flexural vibration and the perception of sting in hand-held sports implements. 41st International Congress and Exposition on Noise Control Engineering. 2012; 12.


Dupuytren disease is highly prevalent in male field hockey players aged over 60 years


Dupuytren disease is highly prevalent in male field hockey players aged over 60 years.
Considerations on the measurement methods