ORIGINAL ARTICLE

The Influence of the Special Throwing Technique on the Prevalence of Knee Joint Injuries in Judo

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: This study determined the kinds of injuries occurring in judo. The first aim of this study is a knowledge about achievement-orientated training of competing athletes about their history of knee injuries and about the individual special throwing technique (STT). The second aim is to answer the question whether a correlation exists between STT (with special emphasis on seoi nage and uchi mata) and types of knee joint injuries.

Material & Methods: For data collection an anonymized questionnaire was used. The questionnaires of 260 competition-oriented German judoka were analysed: a mean age of 26.5 ± 9.1 years, had a body height of 175.0 ± 13.6 cm, and a body weight of 76.8 ± 15.9 kg. They trained for 16.5 ± 8.2 years with a frequency of 3.5 ± 2.7 times a week.

Results: The knee joint is the most injury affected region in judo ($p<0.05$). There was no significant correlation between the own special throwing technique of a judoka and the occurrence of knee joint injuries in this athlete ($p>0.05$). Most injuries are caused through seoi nage and uchi mata, what is probably caused by the popularity of these techniques. With regard to the number of athletes using a throw as special technique tai otoshi seems to be the most knee joint endangering technique. Uchi mata is the technique causing most anterior cruciate ligament ruptures ($p<0.05$). Bruises of the knee joint appear most often in seoi nage situations ($p<0.05$).

Conclusion: A judoka with an affinity to knee joint injuries is supposed to specialize on hip throwing techniques. This athlete should probably avoid specializing on tai otoshi or uchi mata.

Key words: anterior cruciate ligament · seoi nage · tai otoshi · uchi mata · injury rates

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ACL - anterior cruciate ligament

LCL - lateral collateral ligament

MCL - medial collateral ligament

PCL - posterior cruciate ligament

STT - special throwing technique is the throw a judoka trains most often in uchi komi and attempts most often to throw in randori and competition

Kake - third phase of a throw, where uke gets thrown by tori

Randori - free-style practice with fighting elements

Tori - executor of a technique

Uke - person receiving a technique

Shiai - fight

Introduction

Judo as an intensive combat sport requires complex physical and coordinative abilities [1-3]. Compared to other sports, the risk to get injured in judo appears to be more or less average [4]. Different causes for injuries in judo like postural pattern, body composition or other conditional deficits have been frequently discussed [5-8]. Judo is commonly associated with acromioclavicular injuries [9, 10], but this might not be supported by a small number of rigid data. Attempts of other authors to collect more information about kinds of injuries in judo arrived at the suggestion, that one should focus more on knee joint injuries in judo athletes [11, 12]. Repetition of special throwing techniques during regular training might cause strain type injuries. The data for injuries occurring during training or competition situations is inconsistent [13-15]. There appears a lack in judo research with regard to this problem and it should be desirable collecting more representative data.

Therefore the first aim of this study is a knowledge about achievement-orientated training of competing athletes about their history of knee injuries and about the individual special throwing technique (STT). The second aim is to answer the question whether a correlation exists between STT (with special emphasis on *seoi nage* and *uchi mata*) and types of knee joint injuries.

Based on earlier research and own athletic experience and expertise as coach, five hypothesis are presented:

1. The knee joint is the most frequently injured area in judokas' history.
2. The personally preferred throwing technique has influence on the occurrence of knee joint injuries.
3. *Tori* fights at more risk for knee injuries than *uke*.
4. Knee joint injuries are more frequent with some throws, less frequent with others.
5. More knee joint injuries occur in training situations than in competition.

Material and methods

Methods and Design

For testing the above-mentioned hypotheses a new questionnaire was developed, oriented to other studies [11, 16]. The questionnaire was evaluated by ten judo experts about comprehensibility and modified for higher validity and reliability. For recruitment of higher level judokas, all clubs with teams in the first or second German league in 2013 were initially contacted by phone. With respect to their willingness to cooperate and their number of active high level athletes we sent the required number of questionnaires, including test manual. The coaches were asked to give each judoka time at the beginning of a training session and ensure that everyone answers the questions alone, without help or further information. Afterwards the coach collected all questionnaires and sent them back together. After having received 292 questionnaires, all were marked with numbers to back up the chance for exclusion of a certain group later on. Then all questionnaires were blinded digitalized in Microsoft Excel and IBM SPSS tables for Evaluation.

Participants, Inclusion and Exclusion criteria

All participants must be 18-40 years, to ensure a certain level of answering competence and to avoid drop out because of current knee pain caused by typical diseases in young people such as Sinding Larson Johansson, Morbus Osgood Schlatter or Young Girls Knee Syndrome. They must have attended regular training for the last three years and at least occasionally compete actively. Judokas older than 40 years were not included because we could not exclude age-related knee problems like osteoarthritis. If there was any external trauma, not related to judo, the questionnaire was rejected as well. To be included all questions of the questionnaires had to be completely answered.

Because of the above-mentioned criteria 32 questionnaires were excluded and 260 remained for further analysis, what is a drop out of 12.3 %. The judokas involved in this study had a mean age of 26.5 ± 9.1 years, had a body height of 175.0 ± 13.6 cm, and a body weight of 76.8 ± 15.9 kg. They trained for 16.5 ± 8.2 years with a frequency of 3.5 ± 2.7 times a week.

Statistical Analysis

Significance was tested for nominal characteristics with the Chi-Square-Test and proven by the Fisher-Test, being more resistant for small groups. Association was proven with Yulescher Association coefficient. Correlation for ordinal scaled characteristics was evaluated by Spearman rank correlation coefficient and for metric items with Bravais Pearson correlation coefficient.

Results

In the present sample *seoi nage* was the most common special throwing technique, with 29.6 % of all special throwing techniques. It was followed by *uchi mata* (21.5 %), the group of foot throws (15.4 %), *tai otoshi* and hip throws with each 9.2 % and others (15.1%).

Knee joint injuries occurred in significantly ($p<0.05$) more judokas than any other kind of injury (Figure 1). In the present study 158 judokas (60.8%) claimed at least one serious knee injury in their career. Therefore hypothesis 1 can be accepted.

With regards to the correlation of suffered knee joint injuries to STT, 64.9 % of judoka with *seoi nage* as STT suffered knee joint injuries. Judokas with *uchi mata* 4.3%), foot throws (60.0%), *tai otoshi* (45.8%) and hip throws (52.6%) as STT also experienced a knee injury. No significant differences were found by Chi-Square-Test or Fisher-Test in this case ($p>0.05$). Hypothesis 2, assuming the influence of the own special throwing technique on the occurrence of knee joint injuries must be rejected.

The judokas reported the following situations causing their explicit injury: In 80.4 % it was a throwing situation. In 74 cases, representing 46.8 % of all knee joint injuries *tori* got injured in a throwing situation and in 53 cases (33.5%) it was *uke*. The association coefficient of A=0.32 does not speak in favour of a relevant association between *tori* and the injury. Therefore hypothesis 3 is not accepted.

In 19.6 % of all injury situations the judokas described reasons like ground work, weight lifting, athletics and football in heating up or overloading in training camps. In one case a spectator got injured seriously through *uke* falling on him. Twenty-four athletes, representing 18.9 % of all knee injuries caused by a throwing situation, got injured through *uchi mata, tai otoshi* (18%), *seoi nage* (16%), foot throws (11%) and others with 10% followed up (Figure 2). In 33 cases it was a throwing situation causing the knee injury, but the judoka did not name the exact throw. No situation with a hip throw led to a knee injury.

The correlation analysis with Bravais Pearson correlation coefficient showed a high correlation (r=0,81) between the number of judoka often attempting to throw a certain technique and the amount of the situations this technique led to a knee injury. That is why hypotheses 4 can be accepted, considering the absolute amount of injuries, but should be interpreted with regard to a high correlation between the number of injuries and the number of potential risk situations.

There appears an imbalance between the chance to get injured through a certain technique and the number

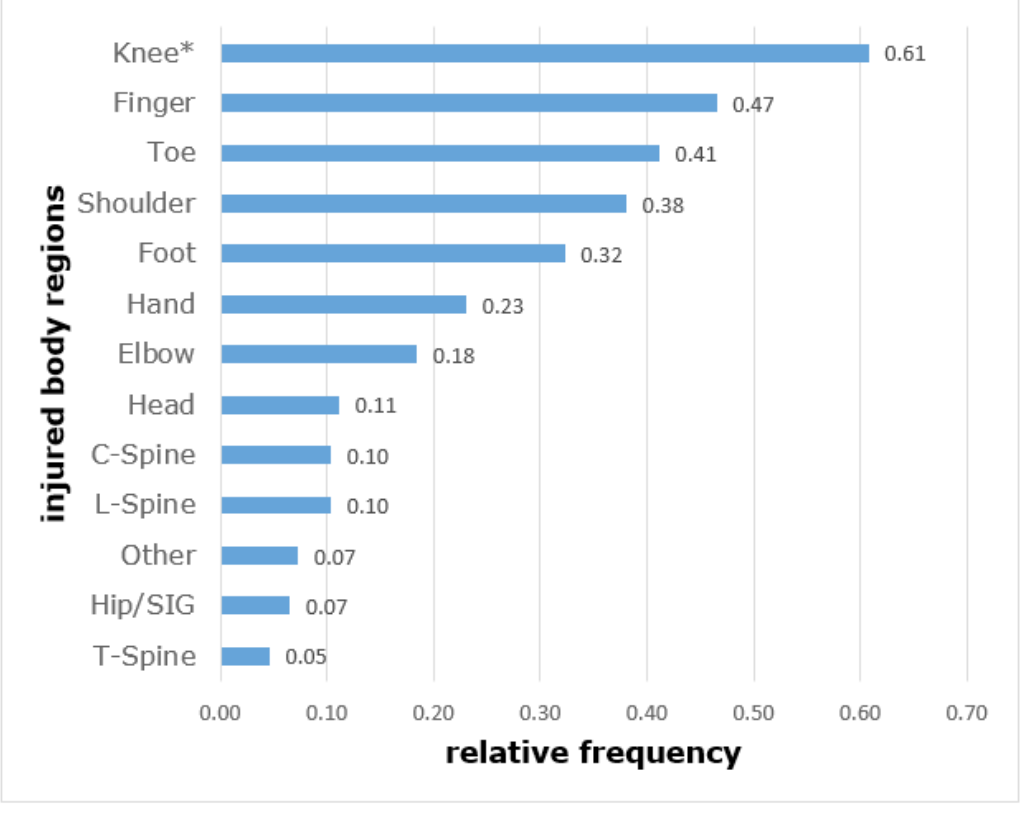

Figure 1: Distribution of injuries in judo (*$p>0.05$) adult judokas (n = 260) - ordinal variable by frequency of events

of athletes throwing that as STT (Figure 2). If someone using *tai otoshi* or *uchi mata* as special throwing technique is involved in a situation, the chance to get injured is significantly ($p<0.05$) higher than the chance caused through the presence of hip throwing judokas or *seoi nage* throwers.

Almost half (46.2%) of all judokas currently suffered from knee pain with an episodical or permanent intensity of 30.80 ± 18.26 at a visual analog scale (0-100) during training sessions. For this group no correlation with Spearman rank correlation ($r=0.19$) was found between training years and current intensity of knee pain while training. Concerning the most common techniques *seoi nage* and *uchi mata*, different types of injuries occurred. The most common type of knee injuries associated with *uchi mata* was the rupture of the ACL, which occurred in 45.8% (Table 1). In only 15% of similar situations caused by *seoi nage* the same ACL injury occurred. When *seoi nage* was the technique leading to knee joint injury, a contusion of the knee joint occurred in 70%, while it was in 37.5% in *uchi mata* and even less in other techniques. This differences are significant ($p<0.05$). Knee injuries occur in training-situations (21.2%), randori in training (47.1%) and competition (31.7%), what means that most knee joint injuries occur outside competition. This fact is significant ($p>0.05$), and therefore hypothesis five can be accepted.

Discussion

The knee joint is the most frequent injured region in judo, followed by finger and toe injuries. This is important to consider when implementing prevention programs and for the evaluation of the technical-tactical preparation of a judoka especially after an injury. There was no significant correlation between the own STT and the risk of suffering from knee injuries. However, with respect to the idea that special throwing

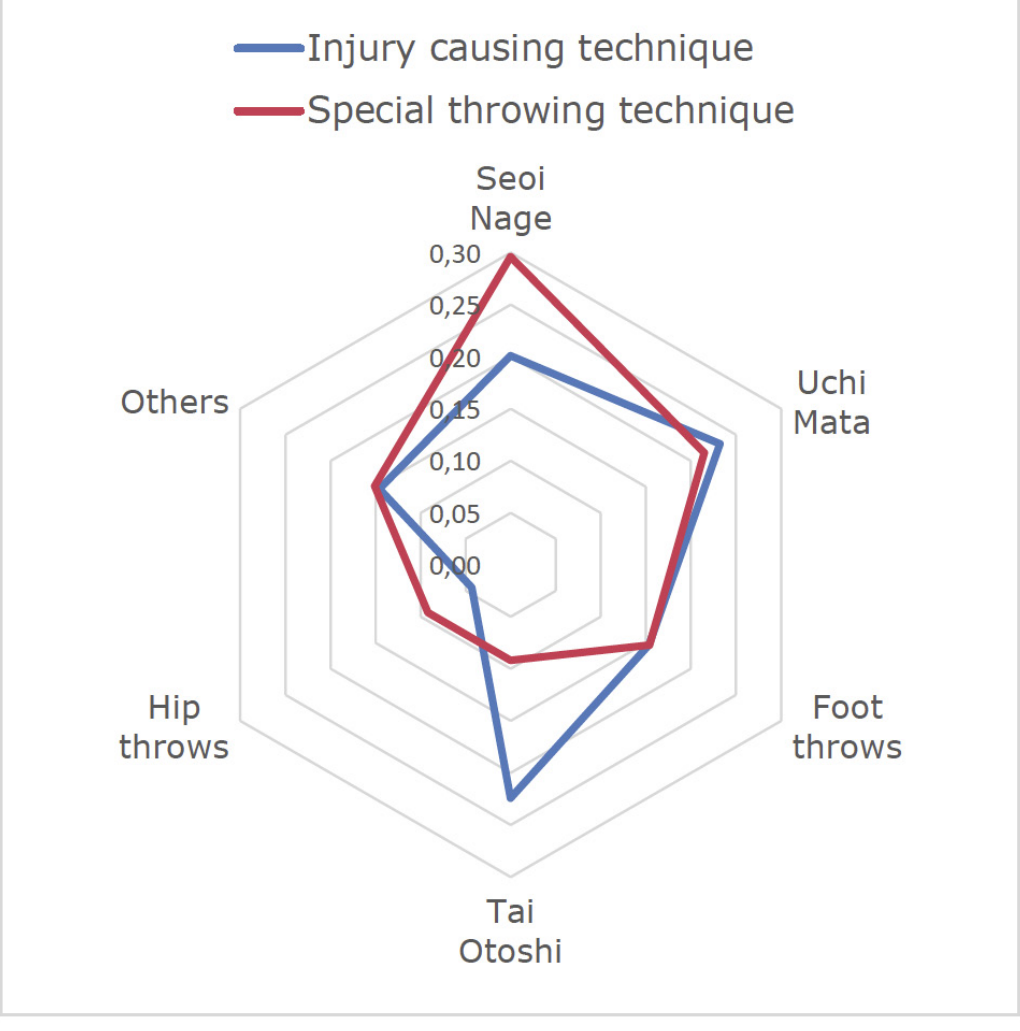

Figure 2: Relation between special throwing technique and injury adult judokas (n = 260)

Table 1. Relative frequency of kinds of injuries adult judokas (n = 260) associated with the most common techniques when knee injury occurred

	Uchi mata	Seoi nage	Tai otoshi	Foot throws
Muscle injury	0.21	0.20	0.26	0.29
Contusion	0.38	0.70	0.43	0.21
Meniscus	0.50	0.30	0.52	0.43
ACL	0.46	0.15	0.26	0.07
PCL	0.00	0.05	0.04	0.07
Patella	0.04	0.15	0.17	0.36
MCL	0.25	0.10	0.22	0.21
LCL	0.13	0.10	0.13	0.43
Others	0.46	0.45	0.35	0.00

techniques are often used in randori or shiai there obviously exists a if one technique leads to more injuries than others. Attacking frequency, which could differ between man and woman or light and heavy weight [17], of most techniques would be interesting to be analysed in detail about when evaluating this point. With regard to the finding that the number of judokas using a throw as STT correlates highly (r=0.82) with the amount of judokas being injured through this technique, our hypothesis was underlined, even if not completely. Only *tai otoshi* with a factor of 2.44 and *uchi mata* with a factor of 1.08 did injure more athletes in the knee region than judokas using this as STT. The presence of *tai otoshi* specialists in a certain situation does not significantly raise the chance to get injured through this technique. This might be caused by the idea that *tai otoshi* is often a second or third technique in the repertoire of a judoka, but not the first one.

It appears remarkable that no knee joint injuries occurred in hip throwing situations, which might be relevant for rehabilitation of knee joint injured judokas and their reintegration in the training process. In the light of massive rule changes in judo in 2010, *seoi nage* and *uchi mata* are the predominant throws again [18]. It is interesting that an injury caused through *uchi mata* or *seoi nage* correlates highly with the presence of athletes throwing *uchi mata* or *seoi nage* as STT, but not for *tori* or *uke* alone ($p>0.05$). There were no significant results to be found for a higher risk of *tori* or *uke* at all.

Focusing on those two predominant techniques, *seoi nage* and *uchi mata*, the special type of injuries should be considered. One third of all ACL-ruptures occurred in a situation with *uchi mata* being involved. This may be explained with regard to the special biomechanical situation. The *tori* tries to stand monopedally, carrying the whole weight of both competitors with a typical knee joint position of about 168°-169° degrees at the beginning of *kake* against great active resistance [19]. There is few muscular and also few passive joint guidance in this position probably making the knee more vulnerable. More detailed biomechanical studies are suggested to evaluate this context in more detail, focusing on the concrete injury causing moment in an *uchi mata* situation. *Seoi nage* caused injuries correlated significantly with the occurrence of bruises of the knee joint. This tendency had also been reported by other authors [20].

There were small differences between training-situations (21.17%), randoris in training (47.06%) and competitions (31.76%) for the occurrence of knee joint injuries. Trying to analyze this data in context of time- and repetition distribution in randori and competition the following consideration might be useful: In the present study the judokas documented in average 588 randoris per year, calculated by average 3.5 training sessions per week, with four randoris each session times 42 "trainings weeks" a year. They fight in average 22 official fights per year. A fictive injury factor of 0.14 for randori and 2.45 for competition could be created, when all injuries would have happened in the last year. There might be more risk through competition, what could be justified with weight related caloric restriction or a higher aggression potential and other initially mentioned points [21, 22].

Because of the few data for injuries associated with each throw, definite conclusion must be drawn carefully. Especially statistical considerations include the empirical problem of the alpha error accumulation when testing many times on the same sample.

Conclusion

Judo has inherent risks for injuries with a focus on the extremities. The most injured joint is the knee joint. There is no clear evidence for a predictable risk of a knee injury for a judoka in correlation to his or her special throwing technique. With regard to the small number of athletes throwing *tai otoshi* as STT, many athletes got injured in this situation. *Uchi mata* seems to carry a risk factor for injuries to the ACL what should be a strong indication to avoid this technique especially after rehabilitation of an ACL-rupture. *Seoi nage* seems to be a risk factor for bruises of the knee joint as well. The introduction of a test procedure seems useful to evaluate the risks throwing *seoi nage*, *tai otoshi* or *uchi mata* for athletes having especially vulnerable knees.

Highlights

Knee joint injuries are the most common types of serious injuries in judo. Uchi mata seems to be a risk factor for ACL ruptures.

Competing interests

The authors declare that they have no competing interests.

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