Association Between the Initial Anatomical Severity and Opportunity of Return to Work in Occupational Hand Injured Patients

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Background: The severity of the injury is the most important factor to return to work (RTW) when it comes to hand injuries. The purpose of our study is to examine the relationship between the initial anatomic severity, evaluated by the Hand Injury Severity Scoring (HISS) system, and probability of RTW in occupational hand injured patients.

Methods: In this retrospective cohort study, 140 patients hospitalized for surgery due to occupational hand injuries between 2004 and 2008 were recruited. Participants were interviewed for occupational history and RTW status. The probability of RTW was compared with the initial HISS scores by multiple logistic regression models.

Results: In workers’ compensation group, there was a significant relationship between HISS severity and the probability of RTW. Compensated patients with moderate injuries with OR = 0.15; 95% confidence interval (CI), 0.03–0.70 and severe injuries (OR = 0.13; 95% CI, 0.02–0.75) were significantly less likely to RTW than those with minor injuries, and those with major injuries were the least likely to RTW (OR = 0.07; 95% CI, 0.01–0.36). However, no association was found between HISS severity and the probability of RTW for patients without workers’ compensation. With regard to the HISS components, patients with motor or neural component deficits had a significantly lower opportunity of RTW, with the neural deficits being the most influential.

Conclusion: HISS is a useful instrument to predict the opportunity of RTW while restricted to the compensated patients. We also verified that the relationship between HISS severity and the probability of RTW existed for groups but not for individual patients.

Key Words: Return to work, HISS, Occupational hand injury, Epidemiology.

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Occupational hand injury is a common cause of work disability. A severe injury can result in the inability to return to work (RTW), which can lead to the loss of financial support, living difficulties, social problems, and social economic loss. With a clear understanding about the relationship between the ability to RTW and injury severity, we can help people who suffer from severe hand injuries to prepare themselves better. Better planning and retraining can help reduce the pressures that result from the inability to RTW.

The ability to RTW is influenced by many factors such as gender, education level, job, age, workers’ compensation, and salary; however, the severity of the injury is the single most important factor when it comes to hand injuries. The Hand Injury Severity score (HISS) was developed by Campbell and Kay to quantify the severity of hand injuries. Four scores accounted according to four components (Integument, Skeletal, Motor, and Neural) of hand. The scores are summed to calculate a total score and then ranked as four levels of HISS severity.

A few studies have used HISS to predict the functional recovery and some studies used HISS to predict the probability of RTW or time away from work. The previous study results showed a positive relationship between HISS and RTW. However, there are so many variables besides the injury itself influencing the RTW at the same time. Mink Van Der Molen et al. and Wong have mentioned that HISS may be able to predict outcomes for groups (i.e., only for blue-collar group or workers’ compensation group) of hand injuries but not for individual patients.

To our knowledge, there has been no research whether the relationship between HISS and RTW would be different for patient groups with different characteristics, and there is no literature about the relationship between HISS components and the probability of RTW. The purposes of our study are (1) to investigate the relationship between HISS severity and the probability of RTW, (2) to investigate the relationship between HISS component and the probability of RTW, and (3) to examine the validity of the assertion that the relationship between HISS severity and the probability of RTW exists for groups but not for individual patients.

MATERIALS AND METHODS

Patients and Methods

Between September and November 2008, we conducted the this study based on a retrospective cohort design. Patients hospitalized for surgery in the National Cheng Kung University Medical Center, Tainan, Taiwan; Institute of Preventive Medicine, College of Public Health, National Taiwan University, Taipei, Taiwan; National Cheng Kung University, Tainan, Taiwan; and Yungling L. Lee, MD, PhD.

Submitted for publication August 15, 2009. Accepted for publication December 14, 2009. Copyright © 2010 by Lippincott Williams & Wilkins. From the Bureau of Food and Drug Analysis, Department of Health (Y.-Y.L.), Executive Yuan, Taipei, Taiwan; Department of Occupational Therapy (J.-H.C., L.-C.K.), National Cheng Kung University, Tainan, Taiwan; Division of Plastic and Reconstructive Surgery, Department of Surgery (S.-J.S., Y.-C.L.), National Cheng Kung University Medical Center, Tainan, Taiwan; Institute of Preventive Medicine (Y.L.L.), College of Public Health, National Taiwan University, Taipei, Taiwan. Supported by Bureau of Labor Insurance grant 097-0-P1-000048, Taiwan. Address for reprints: Yungling Leo Lee, MD, PhD, Institute of Preventive Medicine, College of Public Health, National Taiwan University, Taipei 100, Taiwan; email: leolee@ntu.edu.tw.

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University (NCKU) Hospital because of occupational hand injury after 2004 were recruited. The inclusion criteria of study participants were as follows: subjects were 15 years to 60 years old at the time of injury; they were employed full-time before injury; at least 6 months had elapsed because of their injuries; and they were all clinically stable, no longer needed splinting devices. The following were excluded from our study: subjects who were unable to answer the questionnaires to, foreign workers, hand injuries proximal to carpus, bilateral hand injuries, and subjects with any histories of severe hand injuries.

There were a total of 336 hand injury patients receiving operation in NCKU Hospital after 2004. One hundred eighty-three subjects met our study criteria, and each had HISS scores successfully assessed by a hand surgeon. All eligible participants were interviewed by phone for demographic information and occupational history. The occupations of the study participants were categorized into two groups: white-collar and blue-collar workers. The white-collar group included managers, professionals, technical, sales, administrative, and service personnel. The blue-collar group included machine operators, laborers, and workers in the following sectors: farming, forestry, fishing, industry, and repairs. Informed consent was obtained from each study participant.

The Hand Injury Severity Scoring System

A hand surgeon reviewed the medical records, which included roentgenograms of the injury on arrival at the emergency department and notes of the findings during the operation. Initial emergency room evaluations and the operation records were translated into HISS scores by using the HISS system form. Hand injury scores were considered in terms of their Integument, Skeletal, Motor, and Neural components and were evaluated over each ray. Weighting factor was given to each roentgenogram according to the functional importance. The methodology also specified certain conditions in which taking the absolute values of the scores or doubling them was required. We calculated the scores according to the HISS standard instruction. A score was obtained for each component by summing up the weighted value of each roentgenograms and the absolute values in each component. The overall HISS is the summation of the scores for each Integument, Skeletal, Motor, and Neural component.

There are four grades of HISS severity. A HISS of 20 points or below is regarded as a “Minor” injury. A HISS score of between 21 and 50 is “Moderate,” between 51 and 100 is considered “Severe,” and 101 and above is “Major.”

Definition of Return to Work

Both the previous study and the plastic surgeon recommended a recovery time of 3 months before removing casts or internal fixations of nonsevere hand injuries. Therefore, 90 days is a reasonable point of investigation to find out whether workers returned to work. The question used to measure RTW was, “How long did it take for you to return-to-work after injury?”

Data Analysis

An unconditional logistic regression model was used to evaluate the risk of returning to work by HISS severity and components. Change in estimate criteria were used to identify potential confounders. Except for the four covariates that did not meet the conventional change in estimate criterion (i.e., dominant injury hand, other diseases effect, daily life assistance, and subvention claims), the regression analyses included the other covariates such as gender, age, marital status, salary level, education level, occupation, and workers’ compensation. Odds ratios (ORs) and 95% confidence intervals (CIs) for the relationships between HISS severity and RTW and HISS components and RTW were calculated with and without adjustments for potential confounders. We also fitted stratified models to account for compensations or the workers’ occupations to assess the relationship between RTW and HISS severity. Individual and joint associations were estimated using indicator variables created for each category, omitting the hypothesized low–low risk category or reference group. For categorical variables belonging to more than two categories, the interaction was evaluated using the likelihood ratio test, comparing the model with cross-classified variables to a reduced model containing indicator variables for the main effects only. All tests assumed a two-sided alternative hypothesis and a 0.05 significance level.

RESULTS

Our study ultimately comprised 140 (76.5%) occupational hand injury patients. Of these, 70.7% were male, 60.7% were married, 67.9% were blue-collar workers, and 72.9% were classified as the workers’ compensation group. The mean age of the total cohort was 42.6 (SD 12.9). Patients were distributed proportionately with respect to salary and education (Table 1).

One hundred (71.4%) patients were classified as the RTW group. Table 2 shows the sociodemographic factors by RTW status and adjusted OR for RTW. Patients who were older, male, married, in the highest salary group, at the highest education level, white-collar, and classified as the workers’ compensation group had higher numbers of RTW. Patients in the highest salary group (>30,001 new Taiwan dollar [NTD] per month) had significantly higher opportunity of RTW than those with salaries <20,000 NTD per month (adjusted OR = 6.50; 95% CI = 1.54–27.46). No other significant risk factors were found to be associated with RTW.

Table 3 shows the relationship between RTW and HISS severity. After adjustment for potential confounders, patients with major injuries (OR = 0.15; 95% CI = 0.04–0.56) were the least likely to RTW, followed by those with severe injuries (OR = 0.26; 95% CI = 0.07–0.90). Trend tests also revealed significant findings both in the unadjusted and adjusted models. We tested the interaction between workers’ compensation and HISS severity and calculated the p to be 0.02. We found no statistically significant relationship in the nonworkers’ compensation group (Table 3). In the workers’ compensation group, patients with moderate injuries (OR = 0.15; 95% CI = 0.03–0.70) and severe injuries (OR = 0.13; 95% CI = 0.02–0.75) were significantly less likely to RTW.
than those with minor injuries, and those with major injuries were the least likely to RTW (OR = 0.07; 95% CI = 0.01–0.36). The p for the trend test in the workers’ compensation group for HISS severity was 0.002 (Table 3).

The mean scores of individual HISS components and the numbers of cases (in percentages) involving each component are shown in Table 4. The integument component had the highest number of cases (85.0%), whereas the neural component had the least number (35.7%). Table 5 shows the relationship between each HISS component and RTW. After adjusting for potential confounders, the effect of each component on RTW was assessed and expressed as the difference in OR across the interquartile range. Significant associations were found for motor (OR = 0.77; 95% CI = 0.62–0.95) and neural deficits (OR = 0.45; 95% CI = 0.27–0.76). Deficits of integument and skeletal components had similar negative effects but did not reach statistical significance (Table 5).

**DISCUSSION**

Our results showed that there is a significant relationship between HISS severity and the probability of RTW within the workers’ compensation group: the more severe the HISS severity, the lesser the probability of RTW. For patients without workers’ compensation, there was no significant relationship between HISS severity and the probability of RTW. With regard to the HISS components, patients with motor or neural component deficits had a significantly lower probability of RTW, with the neural component being the most influential.

In previous studies, patient characteristics that correlated with a higher probability of RTW included being male,10 having a higher education,8,11 having a white-collar job,2,8,12,13 being younger8,15,17 or older,11,16 and not having workers’ compensation.5,8 Our study had some findings that were different from these previous studies. Consistent with literature, our study showed that patients with higher salaries had a significantly higher opportunity of RTW.8 One possible rationale for this is that the lower salary group is mostly populated with manual laborers who tend to have lower rates of RTW.12

Consistent with previous studies, we found that higher HISS severity levels resulted in lesser probabilities of RTW.4,28 Several studies found a significant positive correlation between the HISS severity and the time away from work, including studies by Matsuzaki et al. in 2009 (r = 0.34),28 Wong in 2008 (r = 0.4),5 Mink Van Der Molen et al. in 2003 (r = 0.65),21 Watts et al. in 1998 (r = 0.27),22 and Campbell et al. in 1996 (r = 0.57).18 Similar to Mink Van Der Molen et al.,23 we found the relationship between HISS severity and opportunity of RTW to exist for patients with workers’ compensation; however, we found that the relationship did not exist for patients without workers’ compensation. One possible rationale for this is that patients working in the company with more than five people are required to participate in the Taiwanese worker’s compensation. Because most of the patients with workers’ compensation are employees whose jobs and incomes are relatively stable, they are unlikely to RTW before recovering functionally. Previous studies have shown that self-employed patients RTW significantly earlier than employees.24 This might be because they are more financially dependent on their job and therefore are more motivated to RTW despite the severity of their injuries. Previous studies have suggested a second possible rationale: compensation is a barrier to RTW.5,8 Because workers’ compensation benefits provide a partial income replacement while they are recovering from injury, patients do not feel as pressured to RTW before they recover. Surprisingly, our study shows that the relationship between HISS severity and the opportunity of RTW does not vary depending on the occupation. Previous studies have shown that white-collar patients are more likely to RTW compared with blue-collar patients2,12,13; however, we found that there is no interactive effect (p = 0.08, data not shown) between occupation and HISS severity. We conclude that although HISS is useful for predicting the consequences of hand injury, its findings are only applicable to the compensation group. One should carefully consider this when using HISS to predict the opportunity of RTW in the future.

With regard to the HISS components, we found that motor and neural component deficits had the most significant influence on the probability of RTW, with the neural deficits having the most impact. When we rank patients with injured motor components in descending HISS score order, the probability of RTW of the lower half is 0.77 times that of the top half. Repeating this exercise for patients with injured neural

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**TABLE 1. Demographic Data of the Occupational Hand Injured Patients (N = 140)**

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>99</td>
<td>70.7</td>
</tr>
<tr>
<td>Female</td>
<td>41</td>
<td>29.3</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried</td>
<td>50</td>
<td>35.7</td>
</tr>
<tr>
<td>Married</td>
<td>85</td>
<td>60.7</td>
</tr>
<tr>
<td>Other*</td>
<td>5</td>
<td>3.6</td>
</tr>
<tr>
<td>Salary level (NTD†‡)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20,000</td>
<td>35</td>
<td>30.4</td>
</tr>
<tr>
<td>20,000–30,000</td>
<td>37</td>
<td>32.2</td>
</tr>
<tr>
<td>≥30,001</td>
<td>43</td>
<td>37.4</td>
</tr>
<tr>
<td>Education level (yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>48</td>
<td>34.3</td>
</tr>
<tr>
<td>10–12</td>
<td>54</td>
<td>38.6</td>
</tr>
<tr>
<td>≥13</td>
<td>38</td>
<td>27.1</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White collar</td>
<td>45</td>
<td>32.1</td>
</tr>
<tr>
<td>Blue collar</td>
<td>95</td>
<td>67.9</td>
</tr>
<tr>
<td>Workers’ compensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>27.1</td>
</tr>
<tr>
<td>Yes</td>
<td>102</td>
<td>72.9</td>
</tr>
<tr>
<td></td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>Age (yr)</td>
<td>140</td>
<td>42.6±12.9</td>
</tr>
</tbody>
</table>

* Other marital status includes separation and divorce.
† 33 NTD (New Taiwan Dollar) = 1 USD.
‡ Numbers of subjects do not add up to total N because of missing data.
components, the probability of RTW of the lower half is 0.45 times that of the top half. There are several possible explanations for this. First, a great deal of pain is associated with deficits of the neural and motor components, pain is a barrier to RTW \cite{15,24}, so patients with neural component deficits are less likely to RTW. Second, neural components deficits

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|}
\hline
\textbf{Risk Factors} & \textbf{RTW, N (%)} & \textbf{No RTW, N (%)} & \textbf{Unadjusted OR (95\% CI)} & \textbf{Adjusted OR (95\% CI)} \\
\hline
\textbf{Gender} & & & & \\
Male & 73 (73.7) & 26 (26.3) & Reference & Reference \\
Female & 27 (65.9) & 14 (34.1) & 0.69 (0.31–1.51) & 1.10 (0.43–2.81) \\
\hline
\textbf{Marital status} & & & & \\
Unmarried & 32 (64.0) & 18 (36.0) & Reference & Reference \\
Married & 64 (75.3) & 21 (24.7) & 1.71 (0.80–3.66) & 1.45 (0.47–4.44) \\
Other* & 4 (80.0) & 1 (20.0) & 2.25 (0.23–21.67) & 1.02 (0.08–13.16) \\
\hline
\textbf{Salary level (NTD\textsuperscript{*})} & & & & \\
<20,000 & 20 (57.1) & 15 (42.9) & Reference & Reference \\
20,000–30,000 & 28 (75.7) & 9 (24.3) & 2.55 (1.03–6.31) & 2.07 (0.66–6.48) \\
\geq30,001 & 39 (90.7) & 4 (9.3) & 7.98 (2.53–25.14) & 6.50 (1.54–27.46) \\
\hline
\textbf{Education level (yr)} & & & & \\
<10 & 32 (66.7) & 16 (33.3) & Reference & Reference \\
10–12 & 39 (72.2) & 15 (27.8) & 1.30 (0.56–3.03) & 1.31 (0.42–4.09) \\
\geq13 & 29 (76.3) & 9 (23.7) & 1.61 (0.62–4.20) & 1.59 (0.44–5.79) \\
\hline
\textbf{Occupation} & & & & \\
White collar & 36 (80.0) & 9 (20.0) & Reference & Reference \\
Blue collar & 64 (67.3) & 31 (32.7) & 0.52 (0.22–1.20) & 0.88 (0.31–2.52) \\
\hline
\textbf{Workers’ compensation} & & & & \\
No & 24 (63.2) & 14 (36.8) & Reference & Reference \\
Yes & 76 (74.5) & 26 (25.5) & 1.71 (0.77–3.78) & 1.34 (0.53–3.39) \\
\hline
\textbf{Age (yr)} & & & & \\
43.5 (12.4) & 40.3 (14.0) & 1.02 (0.99–1.05) & 1.03 (0.98–1.08) \\
\hline
\end{tabular}
\caption{The Association Between the Potential Risk Factors and Return to Work (RTW) After Occupational Hand Injuries}
\end{table}

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|}
\hline
\textbf{HISS Severity (Score)} & \textbf{N (%)} & \textbf{Unadjusted OR (95\% CI)} & \textbf{Adjusted OR (95\% CI)} & \textbf{Adjusted OR (95\% CI)} \\
\hline
Minor (<21) & 59 (42.1) & Reference & Reference & Reference \\
Moderate (21–50) & 39 (27.9) & 0.46 (0.18–1.20) & 0.42 (0.14–1.26) & 7.02 (0.50–87.56) \\
Severe (51–100) & 21 (15.0) & 0.33 (0.11–1.01) & 0.26 (0.07–0.90) & 0.13 (0.01–3.10) \\
Major (101+) & 21 (15.0) & 0.22 (0.08–0.67) & 0.15 (0.04–0.56) & 0.23 (0.01–8.51) \\
\hline
\textit{p} for trend & & 0.005 & 0.003 & 0.36 & 0.002 \\
\hline
\end{tabular}
\caption{ORs and 95\% CIs for the Relationship Between Return to Work (RTW) and HISS Severity}
\end{table}

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|c|}
\hline
\textbf{Subtest} & \textbf{Mean \pm SD} & \textbf{Median} & \textbf{Range} & \textbf{Possible Range} & \textbf{Number (% of Involvement)} \\
\hline
Total & 52.3 \pm 64.2 & 24 & 2–368 & 0–1064 & 140 (100.0\%) \\
HISS components & & & & & \\
Integument & 9.8 \pm 14.4 & 4 & 0–80 & 0–472 & 119 (85.8\%) \\
Skeletal & 3.6 \pm 5.8 & 2 & 0–30 & 0–192 & 87 (62.1\%) \\
Motor & 4.3 \pm 8.7 & 0 & 0–43 & 0–256 & 53 (37.9\%) \\
Neural & 2.0 \pm 3.4 & 0 & 0–16 & 0–144 & 50 (35.7\%) \\
\hline
\end{tabular}
\caption{Distribution of the HISS Scores Among the 140 Participants}
\end{table}
TABLE 5. ORs and 95% CIs for the Relationship Between Return to Work (RTW) and HISS Components

<table>
<thead>
<tr>
<th>HISS Components</th>
<th>Q1–Q3</th>
<th>Unadjusted OR (95% CI)*</th>
<th>Adjusted OR (95% CI)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integument</td>
<td>2–12</td>
<td>0.82 (0.66–1.00)</td>
<td>0.77 (0.58–1.02)</td>
</tr>
<tr>
<td>Skeletal</td>
<td>0–4</td>
<td>0.89 (0.72–1.13)</td>
<td>0.90 (0.70–1.17)</td>
</tr>
<tr>
<td>Motor</td>
<td>0–4</td>
<td>0.75 (0.66–0.92)</td>
<td>0.77 (0.62–0.95)</td>
</tr>
<tr>
<td>Neural</td>
<td>0–3.5</td>
<td>0.52 (0.35–0.78)</td>
<td>0.45 (0.27–0.76)</td>
</tr>
</tbody>
</table>

* ORs are expressed for a change in each HISS component by interquartile range.
† Adjusted for gender, age, marital status, salary level, education level, occupation, and workers’ compensation.
‡ p < 0.05.

In conclusion, we found that HISS was a useful instrument to predict the opportunity of RTW when limited to the compensation group. We also verified that the relationship between HISS severity and the probability of RTW existed for groups but not for individual patients. We strongly recommend that occupational therapy departments should provide retraining programs to improve the probability of RTW for patients with hand injuries, especially those with neural or motor component deficits.

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REFERENCES