

The Relationship Between Isolated Hand Injuries due to Occupational Accidents and Cerebral Lateralization in Patients Presenting to the Emergency Department

Acil Servise Başvuran İzole El Yaralanmalı İş Kazalarının Serebral Lateralizasyon İle İlişkisi

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ABSTRACT

Aim: This study aimed to determine the distribution of hand dominance and to evaluate the relationship between the dominant hand and injury site among patients who presented to emergency service with occupational accident and had isolated hand injury.

Material and Methods: This single-center prospective descriptive study included 528 patients who administered to the emergency department due to work accident and were found to have isolated hand injuries between 01.12.2019-01.06.2020.

Results: 369 (69.9%) patients had isolated skin cuts while the rest of the patients had more severe accompanying injuries such as neurovascular and tendon injury, fracture, or amputation. The most common mechanism of injury was hand cuts while using a tool (163 cases, 30.9%). The most commonly affected regions in hand were the first and second fingers. In patients with right hemisphere dominant, the dominant use of the hand that is not suitable for the dominant hemisphere was found to be statistically significantly higher than in patients with left hemisphere dominant (38.1% vs 1.7%, $p<0.0001$).

Conclusion: The risk of isolated hand injury due to occupational accidents appears to be greater in left-handed individuals, and hand injury more commonly involves non-dominant hand in left-handed individuals than the right-handed ones.

Keywords: Dominant hand, dominant hemisphere, hand injury, occupational accidents.

ÖZ

Amaç: Çalışmamızın amacı, iş kazası ile acil servise başvuran ve izole el yaralanması olan hastalarda dominant el kullanım dağılımının belirlenmesi ve dominant el kullanımı ile yaralanma lokalizasyonunun ilişkisinin değerlendirilmesidir.

Gereç ve Yöntemler: Tek merkezli prospektif tanımlayıcı çalışmamıza, 01.12.2019 ile 01.06.2020 tarihleri arasında acil servise iş kazası nedeniyle başvuran ve izole el yaralanması tespit edilen 528 hasta dahil edildi.

Bulgular: Yaralanma türlerinin analizi, 369 (%69.9) hastada izole deri kesileri olduğunu, geri kalan hastalarda ise nörovasküler ve tendon yaralanması, kırık veya amputasyon gibi daha ciddi eşlik eden yaralanmaların olduğunu gösterdi. En sık yaralanma mekanizması alet kullanırken elle kesmeyi (163 vaka, %30.9). Elde en sık etkilenen bölgeler birinci ve ikinci parmaklardı. Sağ hemisfer dominant olan hastalarda dominant hemisfere uygun olmayan elin dominant olarak kullanımı sol hemisfere dominant olan hastalara göre istatistiksel olarak anlamlı oranda yüksek saptandı (38.1% vs 1.7%, $p<0.0001$).

Sonuç: Sol eli dominant kullanan bireylerde iş kazalarına bağlı izole el yaralanma riski daha yüksek gibi görünmektedir ve el yaralanmasının sağ eli dominant kullanan bireylere göre daha fazla non-dominant elde ortaya çıkmaktadır.

Anahtar Kelimeler: Baskın el, baskın hemisfer, el yaralanması, iş kazaları.

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Introduction

According to the World Health Organization, an occupational accident is defined as an unplanned incident that mostly causes personal injuries, damage to machinery and equipment, and production stop for a period of time. Occupational accidents cause injuries ranging from simple injuries to serious, life-threatening ones (1). In our country, the frequency of this type of injuries is still high despite recent advances in occupational health and a number of preventive measures. Although hand injuries are not included in life-threatening injuries, they are frequently encountered in occupational accidents and cause serious social and functional losses in addition to a great economic burden brought about by their treatment. The hand is one of the most important components of human body, which provides the functionality of an extremity and affects a person in both social and financial ways (2). Risk factors that have been identified for hand injuries include fatigue, inexperience with power machinery, failure to use properly installed safety guards on power tools, reaching into clogged power tools, operating equipment too soon after a meal, and operating power presses (3). Furthermore, some studies have indicated that the dominant hand may be particularly associated with the risk and type of injury (4,5). Nevertheless, there is currently no consensus among the studies reported on this subject as to whether dominant hand is a risk factor for injury or related with the injured region.

This study aimed to determine the distribution of hand dominance and to evaluate the relationship between the dominant hand and injury site among patients who presented to emergency department with occupational accident and isolated hand injury.

Material and Methods

Study type and design

This single-center prospective descriptive study was conducted in an emergency department (ED) of a training and research hospital between 01.12.2019 and 01.06.2020 after receiving approval from the local ethics committee (Date: 13.11.2019, Decision No: 1921/15). The research was conducted in compliance with the criteria of the Helsinki Declaration; written informed consent was obtained from all patients.

Subjects

During the study period, all consecutive patients aged older than 18 years who presented to the ED with isolated hand injuries due to work accidents were included in the study. Patients who were older than 65 years or younger than 18 years, patients with injuries of organs other than hand, or patients with a history of previous hand surgery were excluded from this study.

Study protocol

All patients included in the study were evaluated and examined by emergency physicians in ED at the time of admission. Patients' demographic and clinical data, vital signs, physical/neurological examination findings, the injured hand, skin-tendon cuts, neurovascular injury, fractures, and radiological views (if indicated) were obtained and recorded by the emergency physicians.

After the acute treatment process, all patients were questioned which hand they used as the dominant hand, and their replies were recorded on the relevant study form. Then, in order to clearly determine which hemisphere of a subject was dominant, "Eye deviation" and "Dominant eye" tests were performed. The dominant hemispheric side was similarly recorded on the study form (6,7).

Statistical analysis

All study data were analyzed with SPSS v25.0 for Mac OS X (SPSS Inc., Chicago, IL, USA). Normality of data distribution was determined by the Shapiro–Wilk test, histograms, and Q-Q plots. The categorical variables were expressed as number and percentage and analyzed using the Chi-square test. Continuous variables were presented as the mean±standard deviation (SD) or median and interquartile range (IQR) of 25–75%. Nonparametric continuous parameters were analyzed using the Mann–Whitney U test, and the parametric ones were analyzed using the Student's t-test. The 95% confidence intervals (95% CIs) were calculated whenever appropriate, and a two-tailed p value of <0.05 was considered statistically significant.

Results

This study included a total of 528 patients who presented to ED after an occupational accident and were diagnosed with hand injury during the study period. Of the patients included in the study, 419 (79.4%) were male; the mean age of the study population was 37.5±11.4 years. An analysis of the injury types showed that 369 (69.9%) patients had isolated skin cuts while the rest of the patients had more severe accompanying injuries such as neurovascular and tendon injury, fracture, or amputation (Table-1).

The most common mechanism of injury was hand cuts while using a tool (163 cases, 30.9%). The most commonly affected regions in hand were the first and second fingers (Figure-1). When the true dominant hemisphere of the patients was determined with the "Eye deviation" and "Dominant eye" tests, independently of the self-declared and the used dominant hand, we found that the left hemisphere was the dominant hemisphere in 297 (56.3%) patients, of whom 5 (1.7%) declared that they used their left hand as the



Figure 1. Affected parts of the hand

Variable	N=518
Gender n (%)	
Male	419 (79.36)
Female	109 (20.64)
Age, median (IQR 25-75%)	37.50 (22-47)
Mechanism of injury (%)	
Injury while using a small work tool	135 (25.56)
Lifting heavy objects	68 (12.87)
Direct cuts with a work tool such as a knife or a handsaw	163 (30.87)
Crush with blunt-shaped, unsharpened work tools	94 (17.80)
Hand squeezed by heavy-tonnage big work machines	64 (12.12)
Other undefined occupational injuries	4 (0.75)
Injury type n (%)	
Isolated skin cut	369 (69.88)
Neurovascular injury in addition to skin injury	97 (18.37)
Tendon injury in addition to skin injury	24 (4.54)
Fracture in addition to skin injury	16 (3.03)
Amputation	22 (4.16)
Dominant Hand, n (%)	
Right hand	380 (71.96)
Left hand	148 (28.03)
True Dominant hand, n (%)	
Right hand	297 (56.25)
Left hand	231 (43.75)
Affected Hand, n (%)	
Dominant hand	148 (28.03)
Non-dominant hand	291 (55.11)
Both hands	89 (16.85)

Table 1. Patient Characteristics

dominant hand. In 231 (43.7%) patients, on the other hand, the right hemisphere was determined as the dominant hemisphere; contrary to expectations, however, 88 (38.1%) of them declared that they used the right hand as the dominant hand. In patients with right hemisphere dominance, the rate of hand dominance that did not match the dominant hemisphere was significantly higher than patients with left hemisphere dominance (38.1% vs 1.7%, $p < 0.0001$).

The analysis of hand dominance revealed that a great majority of patients (380 cases-72%) declared using their right hand as the dominant hand (right-handed group) while the remaining 148 (28%) patients were using their left hand as the dominant hand (left-handed group). An analysis of the injured side showed that both hands were simultaneously injured in a total of 89 (16.9%) patients. While both hands were injured in 67 (17.6%) of the right-handed patients, both hands were injured in 22 (14.9%) of the left-handed patients. No significant difference was found between the right- and left-handed groups regarding the rate of injury of both hands ($p = 0.4$). When the remaining isolated single hand injuries were analyzed by the dominant side ($n = 439$), it was shown that 61% of patients using the right hand as the dominant hand had an injury of the contra lateral non-dominant hand while 79.4% of patients using the left hand as the dominant hand had an injury of the contra lateral non-dominant hand; the difference between the groups was statistically significant ($p < 0.001$) (Table-2).

	Right-Handed n=380 (71.96%)	Left-Handed n=148 (28.03%)	p-value
Both hands injured (n=89)	67 (17.63%)	22 (14.86%)	0.401
One-side hand injured (n=439)	122 (38.97%)	26 (20.63%)	
• Dominant Hand			<0.001
• Non-Dominant Hand	191 (61.02%)	100 (79.36%)	

Table 2. The injured side by the status of hand dominance

Discussion

In our study, where we investigated the relationship between the side of hand dominance and hand injuries due to occupational accident, it was not possible to clearly conclude whether the side of hand dominance was a risk factor for having an occupational accident. However, previous studies have reported a prevalence of 5% and 10% for using left hand as the dominant hand in different populations worldwide (8,9). Nevertheless, the corresponding rate was as high as 28% in our study population, in which a similar rate left-handedness was expected. We believe that such a higher rate than that in the general population may be indirect evidence of left-hand

dominance being a risk factor for hand injuries caused by occupational accidents. Indeed, previous studies have provided evidence supporting our hypothesis. In a study by Coren et al. in 180 left-handed and 1716 right-handed volunteers, it was shown that left-handed individuals had a significantly higher lifetime risk of being injured due to accidents than right-sided individuals (Odds ratio = 1.89 95% CI: 1.39 to 2.58) (10).

Another important clinical question on which we focused in our study was whether the injury rates of dominant or non-dominant hands would differ depending on an individual's handedness status. Accordingly, the rate of non-dominant hand injuries was significantly higher in occupational accidents involving left-handed patients than those involving right-handed patients (79.4% vs 61%; $p < 0.001$). In contrast to our findings, Beaton et al. studied 994 individuals with hand injury and reported no significant difference between the injury rates of the dominant hand or non-dominant hand by the status of hand dominance (11). A study by Hill et al. which involved a greater sample size (4873 subjects) found exactly opposite findings than ours and reported that right-handed individuals had a significantly higher rates of non-dominant hand injury than the left-handed individuals (45% vs 42%; $p < 0.001$) (12). We believe that the most important reason for the discordance between the results of those two studies and our study results may be that our study was limited to occupational accidents whereas the other studies included accident types occurring in all areas of life.

Similar to our results, which showed a rate of 43-37%, a study by Davasaksan et al. on agricultural occupational accidents found that the rate of injury to the first, second, and third finger of hand was 39-30%. Such a higher rate in our study may have resulted from the fact that protective measures taken in agricultural machines and small manual devices are much stricter (13).

Another point we would like to stress is that the proportion of women in isolated occupational accidents was approximately 21% in our study. such a rate in our country, which is a developing country, is similar to the rate of 28%, which was reported by Liu et al. for hand injury rate among female employees in the metal manufacturing industry in China, which is another developing country (14). In contrast, a study by Gravni et al. on isolated hand injuries in United Arab Emirates, an economically developed country, reported that the proportion of women was only 1.4%, which can be explained by a lower number of female employees in that country due to sociocultural factors (15). Another issue we investigated in patients presenting with isolated hand injury is the outcome of the injury. The outcome of the injury has been similarly grouped by many sources. For example, a study by Garg et al. on isolated hand injuries in Hong Kong was conducted on approximately 950

cases; the rate of isolated skin injuries was 70% and the rate of amputation was 4.2%. Although our sample size was about half of that study, our patients had a rate of isolated skin injury of 70% and amputation of 4%. A similar outcome despite the different number of cases may be due to the fact that both studies included employees in quite different occupational groups (16). Similarly, in a study by Mostafa et al., which had a much smaller sample size including 163 patients, the rate of isolated skin injury was 65%, suggesting that injuries related to different occupational groups had an effect on the outcome (17).

Limitations

Our study had some limitations. The first, and the most important, limitation is that our study was conducted in a single center; it involved only individuals with hand injury and lacked controls. We think that the best way of clearly defining whether the side of dominant hand is a risk factor for occupational accidents is to conduct a prospective cohort study involving all individuals working in a certain work area. Therefore, we believe that our study results cannot be generalized. The second limitation is the inability to adequately document certain details such as the working machine that the patients with occupational accidents used, the details of the working vehicle, and whether the tool used was a modified tool for left-handed individuals. The final limitation of our study is that it had a relatively small sample size.

Conclusion

The risk of isolated hand injury due to occupational accidents appears to be greater in left-handed individuals; hand injury more commonly involves non-dominant hand in left-handed individuals than the right-handed ones.

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