**Hand Trauma: A prospective observational study reporting diagnostic concordance in emergency hand trauma which supports centralised service improvements.**

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**ABSTRACT**

**Background:** Hand injuries are common, contributing up to 30% of accident and emergency (A&E) attendances. The aim of this study was to prospectively analyse the pathological demographic of hand injuries, and compare clinical with intra-operative findings, in a level 1 trauma centre Hand Trauma Unit with direct A&E links. The null hypothesis was that no differences would be demonstrated between clinical and intra-operative findings (100% diagnostic concordance).

**Methods**: Data were prospectively collected for referrals during 2012. Referral diagnosis, additional pathologies found on clinical assessment and intra-operative findings were documented on a live database accessible from both the Hand Unit and associated operating theatres. Odds ratios were calculated using SAS.

**Results**: Injuries (1526) were identified amongst 1308 patients included in the study. Diagnostic concordance between Hand Unit clinical examination and intra-operative findings was 92.5%±2.85% (Mean ±SEM); this was lower for flexor tendon injuries (56.3%) due to a greater number of additional pathologies found intra-operatively (2.25±0.10). This ‘trend’ was noted across multiple referral pathologies including phalangeal fractures (1.28±0.02; 82.9%), lacerations (1.33±0.04; 79.1%), extensor tendon injuries (1.30±0.05; 87.8%) and dislocations (1.18±0.05; 87.8%). Odds ratio analysis indicated the relationship between primary referral diagnoses that were more or less likely to be associated with additional injuries (p<0.05); referral diagnoses of flexor tendon injuries and lacerations were most likely to be associated with additional injuries.

**Conclusions:** A high level of suspicion should be reinforced amongst A&E personnel when ascertaining structural damage with hand injuries. Our findings, coupled with presented relevant literature reports, lead us to advocate that A&Es move towards a system with a low threshold for referral to specialist hand trauma services; we hereby present useful data for hospitals implementing such services.

**Keywords:** Hand trauma; diagnosis; management; service provision; trauma centre.

**Introduction:**

Hand injuries are the most common presentation to accident and emergency departments (A&E), accounting for 10%-30% of all attendances.[1-4](#_ENREF_1) Accurate assessment and treatment is vital as mismanagement may result in long term disability, loss of work and/or income, livelihood, psychological issues and withdrawal from society in extreme cases.[5](#_ENREF_5) The impact of hand injuries is extensive; direct treatment costs including initial management, surgery, inpatient stay, sick leave and outpatient attendances have been reported to cost over £100 million per annum.[6](#_ENREF_6), [7](#_ENREF_7) Indirect costs in Europe, such as lost wages, company or industry costs, have been estimated to be six times that of the direct costs, with similar financial implications of upper limb injuries having been reported in America.[8](#_ENREF_8), [9](#_ENREF_9)

Significant hand trauma in particular, should initially be managed according to ATLS principles i.e. prioritised within the context of the primary survey, with remaining injuries detected as part of the secondary survey. It is essential to obtain detailed medical, employment and social history and perform a thorough clinical examination taking into account the patient’s age, handedness, employment, relevant hobbies and most importantly, details of the mechanism of injury.[10](#_ENREF_10) Radiological investigations should include anterior-posterior and true lateral radiographs of affected parts often including neighbouring joints. If the wound is very small and does not appear to be associated with functional deficit or is located away from relevant deeper structures, skilful exploration of the zone of injury (with due consideration of iatrogenic injury) under local anaesthetic using surgical magnification (loupes), might enable direct visualisation of deeper structures e.g. tendons and nerves and their integrity or lack of. If the injury is superficial, or these structures are spared in the case of a deeper zone of injury, simple wound washout, debridement and wound closure in the A&E department may be appropriate, avoiding a need for an operation, admission, delays and often, general anaesthetic and unnecessary starving.

Suspicion of deeper injury however, warrants immediate tertiary referral to a hand surgery service. It is therefore imperative for healthcare professionals to have a thorough understanding of the spectrum of injuries commonly seen, and in particular, which of these injuries require a high index of suspicion and subsequent referral and which do not. Furthermore, these data would provide useful information for hospitals wishing to implement their own specialist tertiary referral hand surgery service.

**Aim:**

The aim of this study was to prospectively analyse the pathological demographic of hand injuries, and compare clinical with intra-operative findings (diagnostic concordance), in a level 1 trauma centre with a specialist Hand Trauma Unit and direct A&E links. Associated injuries found intra-operatively for each primary referral diagnosis were also compared. The null hypothesis was that no differences would be demonstrated between primary referral / Hand Trauma Unit clinical findings and intra-operative findings (100% diagnostic concordance). Such data would provide useful insight for hospitals considering implementing a specialist hand service.

**Methods:**

Consecutive patients were prospectively collected using a standardised online referral form which included one or multiple discrete exploratory diagnoses based on the initial clinical examination performed by the A&E’s referring clinician (Registrar or Consultant) [index test]. All adults with non-life/limb threatening hand injuries referred by A&E departments in South-West London and Surrey (the St. George’s Hospital catchment area over the course of 2012) were included in this study. Children, patients who failed to attend clinic and patients who did not require operations were excluded (Figure 1).

Specialist hand examination was performed either by a Registrar or Consultant at the Hand Trauma Unit. The prospective data were entered into a standardised database designed to facilitate time-specific data entry including primary referral and clinical assessment diagnoses. Patients who underwent surgery were followed up and correlation ascertained between referral diagnosis and intra-operative findings (gold standard for diagnosis). No surgeons were ‘blind’ to the primary referral diagnosis. All intra-operative findings were recorded as discrete diagnoses. Odds ratios were calculated to ascertain the relationship between primary referral diagnoses that were more or less likely to be associated with additional. The risk of further pathology was calculated as the percentage of patients with multiple undiagnosed pathologies being found intra-operatively for each primary referral diagnosis. This diagnostic study adheres to the STARD guidelines.[11](#_ENREF_11) All statistics were calculated using SAS.[12](#_ENREF_12)

**Results:**

There were 1,475 patients prospectively referred with acute non-life/limb threatening hand injuries (Figure 1). Of these, 1,308 patients met the inclusion criteria, with 1526 primary referral diagnoses and 17 pathologies. The number of injuries found after specialist hand unit clinical assessment and surgical exploration are listed for each primary A&E referral diagnosis (Table 1). No indeterminate diagnoses were reported on primary referral or intra-operatively. The mean time course between specialist clinical examination and an operation was 2.95±0.16 days (Mean±SEM). No adverse events were reported following initial examination or surgical intervention. The risk of further pathology being present after primary referral is also shown (Table 1).

Overall, the mean diagnostic concordance between hand unit clinical assessment and intra-operative findings was 92.5%±2.85% (Mean±SEM); further diagnostic concordance values are presented (Table 1). Of particular note, flexor tendon injuries carried the poorest diagnostic concordance accuracy (56.3%) and also carried the highest risk of associated injuries being present after primary referral (80.5%) (Tables 1 & 2). This ‘trend’ was noted across multiple referral pathologies including phalangeal fractures (1.28±0.02; 82.9%), lacerations (1.33±0.04; 79.1%), extensor tendon injuries (1.30±0.05; 87.8%) and dislocations (1.18±0.05; 87.8%), which were also found to be more frequently associated with concomitant injuries. Odds ratio analyses indicated the relationship between primary referral diagnoses that were more/less likely to be associated with additional injuries (p<0.05) (Table 2); referral diagnoses of flexor tendon injuries and lacerations were most likely to be associated with additional injuries (Table 2).

**Discussion:**

This study presents representative data of the broad spectrum of hand trauma encountered in a busy level 1 trauma centre specialist Hand Trauma Unit with direct links to A&E departments. To the best of our knowledge, the diagnostic epidemiological data and concordance between clinical assessment and intra-operative findings presented in this study is based on the largest pool of prospectively followed cases published to-date.

Overall, the mean diagnostic correlation of clinical assessment with intra-operative findings was good, however flexor tendon injuries in particular were associated with lower diagnostic concordance. Compared to other studies, we have reported better mean diagnostic concordance for hand injuries (92.5%±2.85%) assessed by specialist hand unit assessment.[13](#_ENREF_13), [14](#_ENREF_14) Dehgani et al. reported injuries limited to penetrating lacerations of the forearm only (n=250), with A&E physicians performing all examinations, giving a diagnostic error of 26.9% (diagnostic concordance rate of 73.1%); this study however, reported only 3 traumatic pathologies (tendons, nerves and arteries).[14](#_ENREF_14) In Gibson et al., a smaller retrospective study where injuries were limited to flexor zone 5 lacerations (n=50) and examined by post-graduate physicians with 2-3 years of clinical experience, a diagnostic correlation of 67% was reported.[13](#_ENREF_13) In a study of 101 patients with tendon, nerve and arterial injuries, undergoing exploratory hand surgery following trauma, diagnostic accuracy following A&E staff examinations was ≥10% lower than when injuries were assessed by a hand surgeon.[15](#_ENREF_15) These findings are highly supportive of a system whereby A&E departments are directly linked to a specialist hand trauma service; the differences in concordance rates are likely influenced by the level of specialist training received by clinicians assessing hand injuries. Specialist training may improve the ability of clinicians to accurately assess injuries when an examination may be limited by pain, swelling or other practical difficulties when performing diagnostic manoeuvres.

Our diagnostic epidemiological study highlights that the primary diagnosis of flexor tendon injury carries the poorest diagnostic concordance accuracy (56.3%) with the highest risk of additional associated structural injuries to those reported at primary referral (80.5%). Furthermore, odds ratio calculations demonstrate that flexor tendon injuries are significantly more likely to have further associated injuries compared with the other diagnoses (p<0.05) (Table 2). This is usually due to the penetrating mechanism of trauma (often a knife or glass) imposed upon the hand which contains many delicate anatomical structures in proximity (superficial and deep flexor tendons, joint capsulo-ligamentous system, arteries and nerves) (Tables 1 & 2).[16](#_ENREF_16) The aforementioned findings advocate a high index of suspicion and low threshold for surgical exploration of injuries affecting such pathological structures where a high risk of concurrent injury exists.

For the purposes of this study, we define the term ‘incomplete diagnosis’ as any diagnosis found intra-operatively that was not documented on the initial online referral form (Table 1). In our study, ‘incomplete diagnoses’ did not affect patient outcome as all patients underwent surgical exploration. It is likely that there will be a cohort of patients (not included in our data collection) who were never referred from A+E and had ‘incomplete diagnoses’. We recognise that we are unable to accurately quantify the true burden of injury in this cohort as incidence data would be hampered by too many confounding factors e.g. the patient’s willingness to present a second time, other subsequent confounding injury events and direct referral from primary care to other trusts or specialties. Furthermore it is likely that if diagnoses were incomplete by the referring A+E department, then this would not have been documented in the patient’s A+E notes at initial assessment. However, by demonstrating the association between initial referral diagnoses and ‘incomplete diagnoses’ as compared to intra-operative findings, we hope to raise the awareness of potentially hidden pathology and hence the index of suspicion; thereby reducing the numbers of patients who might not be referred in the future and also reducing the incidence of potential resultant long term disability.

Our study data suggest that ‘lacerations’ had a poor diagnostic concordance (79.1%). The likely reason for this was the fact that the term ‘laceration’ was used as an umbrella term for the initial referral diagnosis from the A+E department, despite the fact that further diagnoses were prompted by the receiving team using the standardised referral form. Many of these injuries were complex, extensive or deep and hence could not undergo primary closure in the A+E department. These lacerations therefore required intra-operative exploration, washout and/or debridement. Careful exploration under these conditions then revealed multiple other discrete pathologies such as partial tendon rupture, which accounts for the poor diagnostic concordance between the initial primary referral for ‘laceration’ and the reported intra-operative findings.

Our study recruited 1526 injuries observed in 1308 patients because some patients presented with multiple injuries. We have calculated odds ratios to determine which primary referral diagnoses were more likely to be associated with multiple pathologies. Although some of the injuries may have presented at the same time the odds ratio estimates are not compromised because we can assume the independence of observations based on each of the injuries having their own unique pathology and treatment. One limitation of our study is that we excluded those patients who did not undergo surgery. The aim of this study was to accurately report the diagnostic concordance and associated injuries for each referral diagnosis. Perioperative clinical examination of upper limb injuries has demonstrated an 8-14% error rate when compared to intra-operative findings in the literature.[14](#_ENREF_14) It is possible that some of the patients who were referred and did not require surgery may have had ‘incomplete diagnoses’ however the unsatisfactory error rate associated with clinical examination, when compared to intra-operative findings, rendered its use as a reference standard unreliable.

It is well known that hand injuries may result in long term disability, inability to work, psychological issues and withdrawal from society in extreme cases.[5](#_ENREF_5) A lack of relevant clinical knowledge is likely to result in a gross underestimate of certain hand injuries, inaccurate diagnosis and poor management.[17-20](#_ENREF_17) As hand injuries are a common presentation to A&E departments, greater emphasis should be placed on training clinicians in the management of hand trauma.[1-4](#_ENREF_1) Our high diagnostic concordance findings for specialist clinical examination, coupled with lower concordance reports in the literature for non-specialist examination, lead us to advocate that A&Es move towards a system whereby links to specialist hand trauma services are in place, and we hereby present useful data for hospitals considering implementation of such services.[13-15](#_ENREF_13), [21](#_ENREF_21)

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**Conflict of Interests:**  None

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**FIGURE LEGENDS:**

**Figure 1: Patient recruitment flow chart.** Of the 1475 patients referred, 1308 were included in the study. Of the 167 patients excluded, 94 were deemed not to require an operation, 47 failed to attend their appointments and 26 were paediatric patients (referred inappropriately).

**TABLE LEGENDS:**

**Table 1: Mean number of diagnoses after hand unit assessment, mean number of diagnoses found intra-operatively, diagnostic accuracy (concordance) between hand unit assessment and intra-operative findings and the risk of further pathology being present based on intra-operative findings, for each A&E hand injury primary referral pathology.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **A&E hand injury primary referral diagnosis** | **Mean number of individual diagnoses after specialist hand unit assessment (±SEM)** | **Mean number of individual diagnoses found intra-operatively (±SEM)** | **Concordance of hand unit examination & intra-operative findings** | **Risk of further pathology being present based on intra-operative findings** |
| **Flexor Tendon**  | 1.82±0.84  | 2.25±0.10 | 56.3% | 80.5% |
| **Extensor Tendon** | 1.18±0.04 | 1.30±0.05 | 87.8% | 27.8% |
| **Phalanx Fracture** | 1.11±0.02 | 1.28±0.03 | 82.9% | 27.7% |
| **Laceration** | 1.12±0.03 | 1.33±0.04 | 79.1% | 26.2% |
| **Nail Bed** | 1.02±0.04 | 1.02±0.04 | 100% | 18.8% |
| **Dislocation** | 1.06±0.03 | 1.18±0.06 | 87.8% | 18.4% |
| **Mallet Deformity** | 1.17±0.04 | 1.17±0.04 | 100% | 16.9% |
| **Foreign Body**  | 1.05±0.04 | 1.18±0.05 | 86.9% | 16.1% |
| **Infection** | 1.06±0.04 | 1.13±0.06 | 93.8% | 12.1% |
| **Metacarpal Fracture** | 1.12±0.02 | 1.13±0.02 | 98.6% | 12.0% |
| **Collateral Ligament** | 1.03±0.03 | 1.03±0.03 | 100% | 10.0% |
| **Bennett's Fracture** | 1.06±0.01 | 1.06±0.01 | 100% | 5.9% |
| **Nerve** | 1.06±0.02 | 1.06±0.02 | 100% | 5.6% |
| **Amputation** | 1.05±0.01 | 1.05±0.01 | 100% | 4.6% |
| **Volar Plate** | 1.03±0.03 | 1.03±0.03  | 100% | 3.0% |
| **Boutonniere's Deformity**  | 1.00±0.00 | 1.00±0.00 | 100% | 0% |
| **Dog Bite** | 1.00±0.00 | 1.00±0.00  | 100% | 0% |

**Table 2:**

**The relationship between primary referral diagnoses that were more/less likely to have further associated injuries, according to intra-operative findings.** The values for mean number of intra-operative diagnoses for each pathology are stated previously (Table 1). Odds ratios and 95% confidence intervals are given for the relationship between those primary referral pathologies that were more likely, over those that were less likely, to have further associated injures (p<0.05).

|  |  |
| --- | --- |
| **Primary diagnosis more likely to have further associated injuries** | **Odds ratio calculations indicating the primary diagnoses that were less likely to have further associated injuries according to intra-operative findings (p<0.05)** |
| **Diagnosis**  | **Odds ratio** | **95% Confidence interval** |
| **Flexor Tendon**  | Extensor tendonPhalanx FractureLacerationNail BedDislocationMallet deformityForeign Body Metacarpal FractureInfectionCollateral LigamentBennett’s FractureNerveAmputationDog biteBoutonniere’s fractureVolar plate | 0.0940.0900.0860.0560.0550.0490.0480.0350.0350.0270.0150.0140.0120.0110.0100.008 | 0.048 to 0.1830.049 to 0.1650.047 to 0.1590.029 to 0.1110.022 to 0.1300.022 to 0.1100.020 to 0.1130.019 to 0.0660.011 to 0.1120.007 to 0.1000.002 to 0.0920.005 to 0.0380.001 to 0.0920.001 to 0.1920.001 to 0.1760.001 to 0.066 |
| **Metacarpal Fracture** | Nerve injury | 0.409 | 0.168 to 1.000 |
| **Phalanx Fracture** | Metacarpal FractureNerve InjuryVolar Plate | 0.3910.1600.093 | 0.250 to 0.6110.067 to 0.3820.012 to 0.695 |
| **Laceration** | Metacarpal FractureNerveVolar plate | 0.4080.1670.097 | 0.257 to 0.6500.069 to 0.4030.013 to 0.730 |
| **Extensor Tendon** | Metacarpal #Nerve InjuryAmputation Volar plate | 0.3760.1540.1240.090 | 0.221 to 0.6420.061 to 0.3860.016 to 0.9570.012 to 0.684 |
| **Foreign Body** | Nerve Injury | 0.303 | 0.104 to 0.880 |
| **Dislocation** | Nerve Injury | 0.264 | 0.088 to 0.790 |
| **Nail Bed**  | Nerve injury | 0.256 | 0.101 to 0.647 |
| **Mallet Deformity** | Nerve Injury | 0.292 | 0.106 to 0.808 |

**Appendix 1- STARD Checklist**

|  |  |  |  |
| --- | --- | --- | --- |
| **Title** |  | Item | Completed/Comments |
|  | 1 | Identification as a study of diagnostic accuracy using at least one measure of accuracy (such as sensitivity, specificity, predictive values, or AUC) | CompletedPage 1 |
| **Abstract** |  |  |  |
|  | 2 | Structured summary of study design, methods, results, and conclusions  | CompletedPage 2 |
| **Introduction** |  |  |  |
|  | 3 | Scientific and clinical background, including the intended use and clinical role of the index test  | CompletedPage 3 |
|  | 4 | Study objectives and hypotheses  | CompletedPage 4 |
| **Methods** |  |  |  |
| *Study Design* | 5 | Whether data collection was planned before the index test and reference standard were performed (prospective study) or after (retrospective study) | Completed Prospective study as indicated on page 4 |
| *Participants* | 6 | Eligibility criteria | CompletedPage 4 |
|  | 7 | On what basis potentially eligible participants were identified (such as symptoms, results from previous tests, inclusion in registry | Completed Page 4 |
|  | 8 | Where and when potentially eligible participants were identified (setting, location and dates)  | Completed Page 4 |
|  | 9 | Whether participants formed a consecutive, random or convenience series | CompletedPage 4 |
| *Test Methods* | 10a | Index test, in sufficient detail to allow replication  | CompletedPage 4 |
|  | 10b | Reference standard, in sufficient detail to allow replication  | Completed Page 4 |
|  | 11 | Rationale for choosing the reference standard (if alternatives exist) | CompletedPage 4 |
|  | 12a | Definition of and rationale for test positivity cut-offs or result categories of the index test, distinguishing pre-specified from exploratory  | CompletedPage 4 |
|  | 12b | Definition of and rationale for test positivity cut-offs or result categories of the reference standard, distinguishing pre-specified from exploratory  | Completed Page 4  |
|  | 13a | Whether clinical information and reference standard results were available to the performers of the index test  | Completed Page 4 Reference standard results collected subsequent to index test.  |
|  | 13b | Whether clinical information and index test results were available to the assessors of the reference standard | Completed page 4 |
| *Analysis*  | 14 | Methods for estimating or comparing measures of diagnostic accuracy  | Completed Page 4 |
|  | 15 | How indeterminate index test or reference standard results were handled  | Completed Page 5 |
|  | 16 | How missing data on the index test and reference standard were handled  | Completed |
|  | 17 | Any analyses of variability in diagnostic accuracy, distinguishing pre-specified from exploratory | Completed Page 4 |
|  | 18 | Intended sample size and how it was determined | Completed Page 4  |
| **Results** |  |  |  |
| *Participants* | 19 | Flow of participants, using a diagram | CompletedFig. 1 |
|  | 20 | Baseline demographic and clinical characteristics of participants | Not included because data not collected. |
|  | 21a | Distribution of severity of disease in those with the target condition  | N/aSeverity of individual diagnoses not compared in this study |
|  | 21b | 21b Distribution of alternative diagnoses in those without the target condition | N/a All diagnoses included |
|  | 22 | Time interval and any clinical interventions between index test and reference standard  | Completed Page 5 |
| *Test Results* | 23 | Cross tabulation of the index test results (or their distribution) by the results of the reference standard  | Completed Table 2 |
|  | 24 | Estimates of diagnostic accuracy and their precision (such as 95% confidence intervals)  | Completed Table 2 |
|  | 25 | Any adverse events from performing the index test or the reference standard | Completed Page 5 |
| **Discussion** | 26 | Study limitations, including sources of potential bias, statistical uncertainty, and generalisability | CompletedPage 7 |
|  | 27 | Implications for practice, including the intended use and clinical role of the index test | Completed Page 6 |
| **Other** | 28 | Sources of funding and other support; role of funders | CompletedPage 7 |

**Appendix 2**

The table demonstrates the raw data, odds ratios (OR) and confidence intervals (CI) for the control diagnosis and corresponding pathologies in the vertical columns and comparative diagnoses in the title row. All values are given to 3 decimal places.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cases with no further pathology | Cases with multiple pathologies | Diagnoses | Metacarpal Fracture | Phalangeal Fracture | Laceration | Nail Bed | Extensor tendon | Nerve | Flexor tendon |
| 255 | 37 | Metacarpal Fracture | xxxxxxxx | OR= 2.560CI= 1.637 - 4.003 p<0.001 | OR= 2.448 CI= 1.539 - 3.894 p<0.001 | OR= 1.600 CI= 0.924- 2.769 p=0.09 | OR= 2.657 CI= 1.558 - 4.533 p<0.001 | OR= 0.409 CI= 0.168 - 1.000 p=0.05 | OR= 28.372 CI= 15.077 - 53.391 p<0.001 |
| 175 | 65 | Phalanx Fracture | OR= 0.391 CI= 0.250 - 0.611 p<0.001 | xxxxxxxx | OR= 0.957 CI= 0.628 - 1.458 p=0.836 | OR= 0.625 CI= 0.374 - 1.044 p=0.07 | OR= 1.038 CI= 0.631 - 1.707 p=0.88 | OR= 0.160 CI= 0.067 - 0.382p<0.001 | OR= 11.086 CI= 6.074 - 20.232 p<0.001 |
| 152 | 54 | Laceration | OR= 0.408 CI= 0.257 - 0.650 p<0.001 | OR= 1.045 CI= 0.686 - 1.593 p=0.836 | xxxxxxxx | OR= 0.654 CI= 0.386 - 1.108 p=0.114 | OR= 1.085 CI= 0.650 - 1.812 p=0.754 | OR= 0.167 CI= 0.069 - 0.403 p<0.001 | OR= 11.590 CI= 6.271 - 21.421 p<0.001 |
| 112 | 26 | Nail Bed | OR= 0.625 CI= 0.361 - 1.082 p=0.09 | OR= 1.6000 CI= 0.958 - 2.672 p=0.07 | OR= 1.530 CI= 0.903 - 2.594 p=0.114 | xxxxxxxx | OR= 1.661 CI= 0.920 - 2.997 p=0.09 | OR= 0.256 CI= 0.101- 0.647 p=0.004 | OR= 17.737 CI= 8.982 - 35.023 p<0.001 |
| 83 | 32 | Extensor tendon | OR= 0.376 CI= 0.221 - 0.642 p<0.001 | OR= 0.963 CI= 0.586 - 1.584 p=0.88 | OR= 0.921 CI= 0.552 - 1.538 p=0.754 | OR= 0.602 CI= 0.334 - 1.086 p=0.092 | xxxxxxxx | OR= 0.154 CI= 0.061 - 0.386 p<0.001 | OR= 10.680 CI= 5.472 - 20.844 p<0.001 |
| 101 | 6 | Nerve | OR= 2.442 CI 1.000 - 5.964 p=0.05 | OR= 6.252 CI= 2.616 - 14.944 p<0.001 | OR= 5.980 CI= 2.480 - 14.420 p<0.001 | OR= 3.906 CI= 1.545 - 9.875 p=0.004 | OR= 6.490 CI= 2.589 - 16.269 p<0.001 | xxxxxxxx | OR= 69.314 CI= 26.031 - 184.563 p<0.001 |
| 17 | 70 | Flexor tendon | OR= 0.035 CI= 0.019 - 0.066 p<0.001 | OR= 0.090 CI= 0.049 - 0.165 p<0.001 | OR= 0.086 CI= 0.047 - 0.159 p<0.001 | OR= 0.056 CI= 0.029 - 0.111 p<0.001 | OR= 0.094 CI= 0.048 - 0.183 p<0.001 | OR= 0.014 CI= 0.005 - 0.038 p<0.001 | xxxxxxxx |
| 64 | 13 | Mallet deformity | OR=0.714 CI= 0.359 - 1.422 p=0.34 | OR= 1.829 CI= 0.944 - 3.541 p=0.07 | OR= 1.749 CI= 0.893 - 3.426 p=0.103 | OR= 1.143 CI= 0.549 - 2.379 p=0.72 | OR= 1.898 CI= 0.922 - 3.909 p=0.08 | OR= 0.292CI= 0.106 - 0.808 p=0.018 | OR= 20.268 CI= 9.128 - 45.003 p<0.001 |
| 51 | 10 | Foreign body | OR= 0.740 CI= 0.346 - 1.583 p=0.44 | OR= 1.894 CI= 0.908 - 3.951 p=0.089 | OR= 1.812 CI= 0.860 - 3.819 p=0.118 | OR= 1.184 CI= 0.531 - 2.637 p=0.68 | OR= 1.966 CI= 0.891 - 4.337 P=0.09 | OR=0.303 CI= 0.104 - 0.880 p=0.03 | OR= 20.996 CI= 8.881 - 49.636 p<0.001 |
| 40 | 9 | Dislocation | OR= 0.645 CI= 0.289 - 1.437 p=0.28 | OR=1.651 CI= 0.759 - 3.591 p=0.21 | OR= 1.578 CI= 0.719 - 3.467 p=0.26 | OR= 1.032 CI= 0.446 - 2.388 p=0.94 | OR= 1.714 CI= 0.747 - 3.930 P=0.20 | OR= 0.264 CI= 0.088 -0.790 p=0.02 | OR= 18.300 CI= 7.466 - 44.852 p<0.001 |
| 28 | 4 | Infection | OR= 1.016 CI= 0.337 - 3.060 p=0.98 | OR= 2.600 CI= 0.878 - 7.699 p=0.085 | OR= 2.487 CI= 0.834 - 7.416 p=0.10 | OR= 1.625 CI= 0.524 - 5.036 p=0.40 | OR= 2.699 CI= 0.877 - 8.306 P=0.08 | OR= 0.416 CI= 0.110 - 1.576 p=0.20 | OR= 28.824 CI= 8.910 - 93.247 p<0.001 |
| 27 | 3 | Collateral Ligament | OR= 1.306 CI= 0.377 - 4.519p=0.67 | OR= 3.341 CI= 0.980 - 11.388 p=0.05 | OR= 3.196 CI= 0.932 - 10.962 p=0.07 | OR= 2.089 CI= 0.589 - 7.416 p=0.25 | OR= 3.469 CI= 0.983 - 12.235 P=0.05 | OR= 0.535 CI= 0.125 - 2.278 p=0.397 | OR= 37.059 CI= 10.047 - 136.692 p<0.001 |
| 29 | 1 | Volar Plate | OR= 4.208 CI= 0.556 - 31.819 p=0.16 | OR= 10.771 CI= 1.438 - 80.688p=0.021 | OR= 10.303 CI= 1.370 - 77.471 p=0.02 | OR= 6.731 CI=0.877 - 51.685 p=0.07 | OR= 11.181 CI= 1.461 - 85.537 P=0.02 | OR= 1.723 CI= 0.199 - 14.892 p=0.62 | OR= 119.409 CI= 15.178 - 939.404 p<0.001 |
| 21 | 1 | Amputation | OR= 3.044 CI= 0.398 - 23.280p=0.16 | OR= 7.798 CI=1.028 - 59.131 p=0.047 | OR= 7.459 CI= 0.980 - 56.779 p=0.05 | OR= 4.875CI= 0.627 37.904 p=0.13 | OR= 8.095 CI= 1.045 - 62.684P=0.05 | OR=1.247 CI= 0.143 - 10.909 p=0.84 | OR= 86.471 CI= 10.858 - 688.633 p<0.001 |
| 16 | 1 | Bennett's Fracture | OR=2.321 CI= 0.299 - 18.020 p=0.42 | OR= 5.943 CI= 0.773 - 45.712 p=0.087 | OR= 5.684 CI= 0.736 - 43.888 p=0.096 | OR=3.714 CI=0.471- 29.284 p=0.21 | OR= 6.168 CI= 0.785 - 48.446 P=0.08 | OR= 0.950 CI= 0.107 - 8.423p=0.96 | OR= 65.880 CI= 8.160 - 531.889 p<0.001 |
| 12 | 0 | Boutonniere deformity | OR= 3.669 CI= 0.213 - 63.268 p=0.371 | OR= 9.321 CI= 0.545 - 159.482 p=0.123 | OR= 8.927 CI= 0.520 - 153.176 p=0.131 | OR= 5.888 CI= 0.338 - 102.617 p=0.224 | OR= 9.722 CI= 0.560 - 168.808 p=0.118 | OR= 1.601 CI= 0.085 - 30.158 p=0.753 | OR= 100.670 CI= 5.684 - 1782.983 p=0.002 |
| 11 | 0 | Dog Bite | OR= 3.376 CI= 0.195 - 58.481 p=0.40 | OR= 8.579 CI= 0.499 - 147.539 p=0.14 | OR= 8.215 CI= 0.476 - 141.687 p=0.147 | OR= 5.417 CI=0.309 - 94.861 p=0.25 | OR= 8.947 CI= 0.513 - 156.151 p=0.13 | OR=1.473 CI= 0.078 - 27.872 p=0.80 | OR= 92.641 CI= 5.205 - 1648.987 p=0.002 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Control (below) | Mallet deformity | Foreign Body | Dislocation | Infection | Collateral | Volar plate | Amputation | Bennetts | Boutonnieres | Dog Bite |
| Metacarpal # | OR=1.400 CI= 0.703 2.788 p=0.34 | OR= 1.352 CI=0.632 - 2.891p=0.44 | OR= 1.551 CI= 0.696 - 3.455 p=0.28 | OR= 0.985 CI= 0.327 - 2.967 p=0.98 | OR= 0.766 CI= 0.221 - 2.651 p=0.67 | OR=0.238 CI=0.031 - 1.797 p=0.16 | OR= 0.329 CI= 0.043 - 2.513 p=0.28 | OR=0.431 CI= 0.055 - 3.344 p=0.42 | OR= 0.273 CI= 0.016 - 4.699 p=0.371 | OR= 0.296 CI= 0.017 - 5.132 p=0.40 |
| Phalanx# | OR= 0.547 CI= 0.282 - 1.059 p=0.07 | OR= 0.528 CI= 0.253 - 1.101 p=0.09 | OR= 0.606 CI= 0.278 - 1.318 p=0.21 | OR= 0.385 CI= 0.130 - 1.139 p=0.09 | OR= 0.299 CI= 0.088 - 1.020 p=0.05 | OR= 0.093 CI= 0.012 - 0.695 p=0.02 | OR= 0.128 CI= 0.017 -0.972 p=0.05 | OR= 0.168 CI= 0.022 - 1.294 p=0.09 | OR= 0.107 CI= 0.006 - 1.836 p=0.123 | OR= 0.117 CI= 0.007 - 2.005 p=0.14 |
| Laceraton | OR= 0.572 CI= 0.292 - 1.120 p=0.103 | OR= 0.552 CI= 0.262 - 1.163 p=0.118 | OR= 0.634 CI= 0.288 - 1.392 p=0.256 | OR= 0.402 CI= 0.135 - 1.199 p=0.102 | OR= 0.313 CI= 0.091 - 1.073 p=0.065 | OR= 0.097 CI= 0.013 - 0.730 p=0.023 | OR= 0.134 CI= 0.018 - 1.021 p=0.052 | OR= 0.176 CI= 0.023 - 1.358 p=0.096 | OR= 0.112 CI= 0.007 - 1.922 p=0.131 | OR= 0.122 CI= 0.007 - 2.099 p=0.147 |
| Nail Bed | OR=0.875 CI= 0.420 - 1.821 p=0.72 | OR= 0.845 CI= 0.379 - 1.882 p=0.68 | OR= 0.969 CI= 0.419 - 2.244 p=0.94 | OR= 0.615 CI= 0.199 - 1.907 p=0.40 | OR=0.479 CI= 0.135 - 1.699 p=0.25 | OR= 0.149 CI= 0.019 - 1.141 p=0.07 | OR= 0.205 CI= 0.026 - 1.595 p=0.13 | OR= 0.269 CI= 0.034 - 2.123 p=0.21 | OR= 0.170 CI= 0.010 - 2.960 p=0.224 | OR= 0.185 CI= 0.011 - 3.232 p=0.25 |
| Extensor tendon | OR= 0.527 CI= 0.256 - 1.085 p=0.08 | OR= 0.509 CI= 0.231 - 1.122 p=0.09 | OR= 0.584 CI= 0.254 - 1.339 p=0.204 | OR= 0.371 CI= 0.120 - 1.140 p=0.08 | OR= 0.288 CI= 0.082 - 1.017 p=0.05 | OR=0.089 CI= 0.012 - 0.684 p=0.02 | OR=0.124 CI= 0.016 - 0.957 p=0.05 | OR=0.162 CI= 0.021 - 1.273 p=0.08 | OR= 0.103 CI= 0.006 - 1.786 p=0.118 | OR= 0.112 CI= 0.006 - 1.951 p=0.13 |
| Nerve | OR= 3.419 CI= 1.237 - 9.451 p=0.02 | OR= 3.301 CI= 1.136 - 9.591p=0.028 | OR= 3.788 CI=1.266 - 11.333 p=0.017 | OR= 2.405 CI= 0.634 - 9.117 p=0.20 | OR= 1.870 CI= 0.439 - 7.970 p=0.40 | OR=0.580 CI= 0.067 - 5.018 p=0.62 | OR= 0.802 (CI= 0.092 - 7.011 p=0.84 | OR= 1.052 CI= 0.119 - 9.323 p=0.96 | OR= 0.625 CI= 0.033 - 11.766 p=0.753 | OR= 0.679 CI= 0.036 - 12.848 p=0.80 |
| Flexor tendon | OR= 0.049 CI= 0.022 - 0.110 p<0.001 | OR= 0.048 CI= 0.020 - 0.113 p<0.001 | OR= 0.055 CI= 0.022 - 0.13 p<0.001 | OR= 0.035 CI= 0.011 - 0.112 p<0.001 | OR= 0.027 CI= 0.007 - 0.100 p<0.001 | OR= 0.008 CI= 0.001 - 0.066 p<0.001 | OR= 0.012 CI= 0.001 - 0.092 p<0.001 | OR= 0.015 CI= 0.002 - 0.123 p<0.001 | OR= 0.010 CI= 0.001 - 0.176 p=0.002 | OR= 0.011 CI= 0.001 - 0.192 p=0.002 |
| Mallet deformity | xxxxxxxx | OR= 0.965 CI=0.391 - 2.381 p=0.94 | OR= 1.108 CI=0.434 - 2.828 p=0.83 | OR= 0.703 CI=0.211 - 2.348 p=0.57 | OR= 0.547 CI=0.144 - 2.076 p=0.38 | OR= 0.170 CI=0.021 - 1.360 p=0.10 | OR= 0.234 CI= 0.029 - 1.901 p=0.17 | OR= 0.308 CI= 0.037 - 2.529 p=0.27 | OR= 0.191 CI= 0.011 - 3.428 p=0.261 | OR= 0.208 CI= 0.012 - 3.744 p=0.29 |
| Foreign body | OR= 1.036 CI= 0.420- 2.555 p=0.94 | xxxxxxxx | OR= 1.148 CI=0.426 - 3.092 p=0.79 | OR= 0.729 CI=0.209 - 2.538 p=0.62 | OR= 0.567 CI= 0.144 - 2.234 p=0.42 | OR= 0.176 CI= 0.021 - 1.444 p=0.11 | OR= 0.243 CI= 0.029 - 2.018 p=0.19 | OR= 0.319 CI=0.038 - 2.685 p=0.29 | OR= 0.196 CI= 0.011 - 3.578 p=0.272 | OR= 0.213 CI= 0.012 - 3.907 p=0.30 |
| Dislocation | OR= 0.903 CI= 0.354 - 2.305 p=0.83 | OR= 0.872 CI=0.323 - 2.348 p=0.79 | xxxxxxxx | OR= 0.635 CI=0.178 - 2.268 p=0.49 | OR= 0.494 CI= 0.122 - 1.992 p=0.321 | OR= 0.153 CI=0.018 - 1.278 p=0.083 | OR= 0.212 CI= 0.025 - 1.785p=0.15 | OR= 0.278 CI=0.032 - 2.375 p=0.24 | OR= 0.171 CI= 0.009 - 3.142 p=0.234 | OR= 0.185 CI= 0.010 - 3.431 p=0.26 |
| Infection | OR= 1.422 CI= 0.426 - 4.745 p=0.57 | OR= 1.372 CI=0.394 - 4.780 p=0.62 | OR= 1.575 CI=0.441 - 5.623p=0.49 | xxxxxxxx | OR= 0.778 CI= 0.159 - 3.805p=0.76 | OR= 0.241 CI=0.025 2.295 p=0.22 | OR= 0.333 CI=0.035 - 3.205 p=0.34 | OR= 0.438 CI= 0.045 - 4.259 p=0.48 | OR= 0.253 CI= 0.013 - 5.070 p=0.369 | OR= 0.275 CI= 0.014 - 5.536 P=0.40 |
| Collateral Ligament | OR= 1.828 CI= 0.482 - 6.937 p=0.38 | OR= 1.765 CI=0.448 - 6.958 p=0.42 | OR= 2.025 CI= 0.502 - 8.170 p=0.32 | OR=1.286 CI= 0.263 - 6.289p=0.76 | xxxxxxxx | OR= 0.310 CI= 0.030 - 3.168p=0.32 | OR= 0.429 CI=0.042 - 4.422 p=0.48 | OR= 0.563 CI=0.054 - 5.875 p=0.63 | OR= 0.314 CI= 0.015 - 6.554 p=0.455 | OR= 0.342 CI=0.016 - 7.156 p=0.49 |
| Volar Plate | OR= 5.890 CI=0.735 - 47.182 p=0.10 | OR= 5.686 CI=0.692 - 46.692 p=0.11 | OR= 6.525 CI=0.783 - 54.388p=0.08 | OR= 4.143 CI=0.436 - 39.385p=0.22 | OR= 3.222 CI=0.316 - 32.882 p=0.32 | xxxxxxxx | OR= 1.381 CI= 0.082 - 23.356 p=0.82 | OR= 1.813 CI=0.106 - 30.967 p=0.68 | OR= 0.787 CI= 0.030 - 20.662 p=0.886 | OR= 0.855 CI=0.032 - 22.551 p=0.93 |
| Amputation | OR= 4.266 CI= 0.526 - 34.584 p=0.17 | OR= 4.118 CI= 0.495 - 34.219 p=0.19 | OR= 4.725 CI= 0.560 - 39.857 p=0.15 | OR=3.000 CI=0.312 - 28.834p=0.34 | OR= 2.333 CI= 0.226 - 24.075 p=0.48 | OR= 0.724 CI= 0.043 - 12.246 p=0.82 | xxxxxxxx | OR= 1.313 CI= 0.076 - 22.624 P=0.85 | OR= 0.573 CI= 0.022 - 15.171 p=0.739 | OR= 0.623 CI= 0.023 - 16.557 p= 0.777 |
| Bennett's # | OR= 3.250 CI=0.395 - 26.711) p=0.27 | OR= 3.136 CI=0.372 - 26.402p=0.29 | OR= 3.600 CI= 0.421 - 30.776 p=0.24 | OR=2.286 CI=0.235 - 22.251 p=0.48 | OR= 1.778 CI=0.170 - 18.569p=0.63 | OR= 0.552 CI=0.032 - 9.426 p=0.68 | OR= 0.762 CI=0.044 - 13.133 p=0.85 | xxxxxxxx | OR= 0.440 CI= 0.016 - 11.739 p=0.624 | OR= 0.478 CI=0.018 - 12.812 P=0.66 |
| Boutonniere's deformity | OR= 5.232 CI= 0.292 - 93.854 p=0.26 | OR= 5.097 CI= 0.279 - 92.960 p=0.27 | OR= 5.864 CI= 0.318 - 108.031 p=0.23 | OR= 3.947 CI= 0.197 - 79.003 p=0.37 | OR= 3.180 CI= 0.153 - 66.289 p=0.46 | OR= 1.271 CI= 0.048 - 33.382 p=0.89 | OR= 1.744 CI= 0.066 - 46.152 p=0.74 | OR= 2.273 CI= 0.085 - 60.634 p=0.62 | xxxxxxxx | OR= 1.087 CI= 0.020 - 59.399 p=0.97 |
| Dog Bite | OR= 4.814 CI=0.267 - 86.749 p=0.29 | OR= 4.689 CI=0.256 - 85.920p=0.30 | OR= 5.395 CI= 0.291 - 99.860 p=0.26 | OR= 3.632 CI=0.181 - 73.008 p=0.400 | OR= 2.926CI= 0.140 - 61.281 p=0.49 | OR= 1.169 CI= 0.044 - 30.842 p=0.93 | OR= 1.605 CI=0.060 - 42.633 p=0.78 | OR= 2.091 CI= 0.078 - 56.011 p=0.66 | OR= 0.920 CI= 0.017 - 50.275 p=0.967 | xxxxxxxx |