



Risk factors of revision surgeries among primary hand infections presenting in emergency services

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ABSTRACT

OBJECTIVE: To determine the risk factors involved in revision surgeries in primary hand infections presenting in emergency department in Civil Hospital Karachi.

METHODS: This prospective observational study was conducted in Department of Plastics and Reconstructive Surgery, Dr. Ruth K. M. Pfau Civil Hospital, Karachi, Pakistan during August, 2021 to April, 2022. Patients of any gender of age 12 years and above, requiring surgical management of primary hand infections were included in this study. The data was recorded in a pre-designed proforma.

RESULTS: Out of 270 patients, 174 (64.4%) were males. Median age of patients was 47 (IQR= 35-55) years. Trauma (n=132, 48.9%), boiling water (n=38, 14.1%), idiopathic (n=34, 12.6%) & foreign bite (n=25, 9.3%) were common mechanisms of injuries. Common infection types were felon (n=80; 29.6%), superficial abscess (n=81; 30%) and deep abscess (n=66; 24.4%). Culture growth was positive in 226 (83.7%) cases. Multiple culture growth (>1 culture) was seen in 15 (5.6%) patients. Methicillin-sensitive *Staphylococcus aureus* (n=85; 37.8%) and Methicillin-resistant *Staphylococcus aureus* (n=75; 33.3%) were most common pathogens isolated. Forty-nine (18.1%) patients underwent reoperation. Chronic kidney disease (CKD) (aOR 10.95; 95% CI: 1.40-85.41), Diabetes Mellitus (aOR 3.33; 95% CI: 1-11.02), positive culture-growth (OR 0.18; 95% CI: 0.04-0.78), increasing total leukocyte count (TLC) [aOR 1.60; 95% CI: 1.27-2.01] and erythrocyte sedimentation rate (ESR) (aOR 1.05; 95% CI: 1.02-1.09) were identified as independent predictor for reoperation.

CONCLUSION: A considerable number of patients underwent reoperation. CKD, Diabetes Mellitus, increasing TLC and ESR at the time of presentation were significant predictors of reoperation.

KEYWORDS: Wounds and Injuries (MeSH); Hand (MeSH); Hand Injuries (MeSH); Infections (MeSH); Hand infections (Non-MeSH); Reoperation (MeSH); Microorganisms (Non-MeSH); *Staphylococcus aureus* (MeSH); Surgical Procedures, Operative (MeSH); Surgery, Plastic (MeSH); Plastic Surgery Procedures (MeSH).

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INTRODUCTION

Hand infections may be developed even after minor wounds and laceration if proper care is not taken by the victims and these infections may cause long-term morbidities and compromised functional activities.¹ There is a wide variation in severity and manifestation of hand infections.² Individual of any age

are affected with hand injuries and infections. About two-third of infections are developed in male population.³ Literature documents an average of 40 years are affected with hand trauma and as a consequence more than one-third of the infections occur.³ Post-operative surgical sites infections rarely occur in hand injury cases, nearly 10% of patients present with surgical site infections.³

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Despite improvements in antibiotic medication and surgical therapies, acute hand infections continue to be a difficult clinical entity to treat.⁴ Hand infections are quickly transmitted and can easily destroy functional structures in brachyprophic anatomic areas in the hand. Loss of function, amputation, or even systemic inflammation that poses a life-threatening risk could result. Therefore, it is crucial to obtain an early diagnosis and receive appropriate therapy in order to preserve hand functionality.²

The majority of the time, effective treatment eliminates the illness and restores normal function. However, hand infections commonly result in problems. Osteomyelitis, stiffness, and soft tissue abnormalities are a few examples of these consequences, which are typically more challenging to cure than the primary infection. The emergence, bacteriology, and consequences of hand infections have all been implicated as being influenced by a wide range of circumstances. Diabetes mellitus, an immune state brought on by an underlying medical disease or medication, and a delay in presentation are risk factors that put patients at risk for problems during the treatment of hand infections.⁵ The work position, kind of occupation, origin, nature, and site of infection, patients' metabolic and nutritional status, age, and gender are other variables that have been proposed to affect the course and outcome of hand infections.^{6,7}

Although it is believed that unplanned

Table I: Demographic and socioeconomic features of study participants

Variables		Frequency (n=270)	Percentage
Age groups (years)	≤ 20	10	3.7
	21-29	40	14.8
	30-39	35	13
	40-49	80	29.6
	50-59	63	23.3
	≥ 60	42	15.6
Gender	Male	174	64.4
	Female	96	35.6
Occupation	Daily wage labor	83	30.7
	Housewife	63	23.3
	Officer worker	26	9.6
	Motor mechanic	23	8.5
	Fisherman	14	5.2
	Factory worker	13	4.8
	Operation theatre technician	13	4.8
	Driver	13	4.8
	Tailor+ motor mechanic	10	3.7
	Housemaid	6	2.2
	Electrician	6	2.2

admissions and reoperations after elective hand surgery are uncommon, these acute complications place a significant strain on both the patient and the healthcare system.⁸ In the era of alternative models, complications also have a significant financial influence on the surgeons who conduct these operations. Despite the significance of these acute consequences for all individuals involved in hand surgery, there is surprisingly little research on them because much of the data comes from extensive administrative databases.^{1,2,9,10} Furthermore, to the best of our knowledge, no such data has been published from Pakistan yet. Uncovering the reoperation rate and its risk factors is important in understanding the technical causes and patients' related factors leading to the failure of primary surgery. The knowledge of reasons of unplanned reoperation will be helpful in designing and revising quality improvement plan intending to reduce unplanned reoperation incidence. Therefore, this study was planned to determine the risk factors involved in revision of surgeries in primary hand infections in our local setup.

METHODS

This prospective observational study

was conducted in Department of Plastics and Reconstructive Surgery, Dr. Ruth K.M. Pfau Civil Hospital, Karachi, Pakistan during August, 2021 to April, 2022. Before commencing the study, the study protocol was approved by the Institutional Review Board (IRB#: IRB-2195/DUHS/Approval/2021/598). Patients of any gender of age 12 years and above, requiring surgical management of primary hand infections were included in this study after taking consent from the patients. Permission was taken from parents if patients were younger than 18 years. Patients with post-operative hand abscess and presenting after receiving surgical interventions from other local healers and pregnant females were excluded from this study.

A previously conducted study reported that 21.7% patients underwent more than one surgical procedure.¹¹ Using 95% confidence interval and 5% precision, a sample of total 262 patients is required. Online available calculator Open-Epi was used to perform sample size calculation. To enlist study participants, a non-probability consecutive sampling method was adopted. Patients presenting to emergency department were assessed by on doctor duty who later informed to relevant team for appropriate

management of the patients and patients were shifted to operating room. The attending physician in emergency room took a detailed history of patients and further treating surgeon also taken detailed history. The collected specimen was sent to laboratory for detection of causative pathogens. Patients were followed as per the hospital protocol to record the need of reoperation. The total follow-up time in this study was 6 weeks. Patients were scheduled to weekly visit in out-patient clinics for purpose of assessing wound condition and need of reoperation. They were advised to present before scheduled time in case of unusual event such as unbearable pain, fever, oozing or for any other operation related symptoms for which they were given detailed counselling. The study end point was reoperation. Patients' demographics including their age, gender, occupation and clinical features such as affected sites, infections and detected pathogens, comorbid, injury mechanism and revision of surgery were documented in a pre-designed proforma by the assigned data collectors. Total leukocyte count (TLC), erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were also assessed at the time of admission.

Data was analyzed through SPSS version 21. Frequencies and percentages were compute for summarizing categorical variables such as age categories, gender, occupation, affected sites, infection type, causative pathogens, injury mechanism, comorbid, dominant hand involvement, smoking status and culture growth. Numerical variables like age was categorized as median with inter-quartile because it was non-normally distributed. Assumption of normality was tested with Shapiro-Wilk test. Univariate odd ratios were calculated by applying logistic regression model for assessing association of patients' characteristics with reoperation. The final multivariable regression model was constructed using variables with $p < 0.25$ in univariate analysis. On the final regression model, p -values of 0.05 or less were regarded as statistically significant.

Table II: Descriptive statistics for clinical characteristics of studied patients

Variables		Frequency	Percentage
Smoker		26	9.6
Comorbidity	Diabetes Mellitus	29	10.7
	Chronic kidney disease	7	2.6
Affected sites	Dorsum	67	24.8
	Index finger	49	18.1
	Middle finger	45	16.7
	Thenar space	30	11.1
	Mid palm	24	8.9
	Thumb	19	7
	Web space	33	12.2
	Ring finger	7	2.6
	Hypothenar	6	2.2
	Forearm	3	1.1
	Palm volar	5	1.9
Infection type	Felon	80	29.6
	Superficial abscess	81	30
	Deep abscess	66	24.4
	Paronychia	33	12.2
	Necrotizing fasciitis	16	5.9
	Osteomyelitis	9	3.3
Causative pathogens	Septic arthritis	3	1.1
	Methicillin-sensitive Staphylococcus aureus	85	37.8
	Methicillin-resistant Staphylococcus aureus	75	33.3
	Polymicrobial	16	7.1
	Streptococcus pyogenes	16	7.1
	Staph epidermidis	14	6.2
	Klebsiella	12	5.3
	Pseudomonas aeruginosa	7	3.1
	Staphylococcus pyogenes	6	2.7
	Coagulase -ve staphylococci	2	0.9
	Streptococcus epidermidis	2	0.9
	Acinetobacter	2	0.9
	Streptococcus pneumoniae	2	0.9
	Group A Streptococcus	1	0.4

RESULTS

Initially total 290 patients were approached for this study. Eight of them agreed to be the part of study but later on before study commencement they refused. Twelve patients were lost to follow-up; 5/12 did not even appear in first follow-up visit and 7/12 came till second follow-up visit and after that they did not appear. Hence a total of 270 patients were finally analyzed in the study.

Out of 270 patients, 174 (64.4%) were males and 96 (35.6%) females. Median age of patients was 47 (IQR= 35-55) years. The most frequent injury mechanism was trauma (n=132,

48.9%) followed by boiling water (n=38, 14.1%), idiopathic (n=34, 12.6%), foreign bite (n=25, 9.3%), insect bite (n=16, 5.9%), animal bite (n=10, 3.7%) and human bite (n=4, 1.5%). Table I shows the details of socio-demographic features of study participants.

Table II shows the clinical characteristics of study participants. Median TLC, ESR and CRP levels were 12.9 (IQR= 11.5-14.2) × 10⁹ cells per liter, 7 (IQR= 4-12) ml/hour and 12 (IQR= 4-16) mg/L respectively. Two-third of the patients presented with hand infection in right hand (n=180, 66.7%) whereas dominant hand was affected in nearly three-fourth of the total patients

(n=202, 74.8%). Total affected sites were 289. Median number of affected sites per patients was 1. Few patients (6.3%) had more than 1 affected site positive. Culture growth was found to be positive in 226 (83.3%) cases. Multiple culture growth (>1 culture) was seen in 15 (5.6%) patients.

Nearly one-fifth of the patients underwent reoperation (n=49, 18.1%). Median time for reoperation was 15 (15-17) days. Out of 49 (18.1%) reoperation cases, incision and drainage was performed in all of the reoperation cases. Debridement was performed in 36 (73.5%) cases and amputation was performed in 7 (14.3%) cases. Out of 7 (14.3%) amputations, 6 (85.7%) amputations were performed to amputate middle finger whereas 1 was performed to amputate index finger.

Table III displays the association of patients' characteristics with reoperation. On univariate analysis, age, chronic kidney disease, diabetes, injury type, increasing number of affected sites, positive culture growth, TLC, ESR and CRP were found to be significantly associated with reoperation. On multivariable regression model, chronic kidney disease, diabetes, positive culture growth, increasing TLC and ESR were identified as independent predictor of reoperation.

DISCUSSION

The present study analyzed that demographics of patients including age and gender were similar to previously existing similar literature.^{1,12-15} This study found that median age of patients was 47 years with majority of the patients (29.6%) in the age range of 40-49 years. Another Pakistani study reported that majority of the affected group with hand injuries were people of age 15-40 years.¹² Another study of similar nature from Peshawar reports mean age of 32 years with most of the affected age group was 26-45 years (58%).¹³ Studies from different part of the world also reported median age of 31 and 32 years.^{1,14} There was predominance of male gender in this study. The predominance of male with in traumatic injuries is consistently report in literature around the world.^{1,13,15} The predominance of males makes sense as they are more engaged in outdoor

Table III: Predictors of reoperation in primary hand infection on univariate and multivariable regression model

Variables		OR(95% CI)	p-value	aOR (95% CI)	p-value
Age (in years)		1.05(1.02-1.08)	**<0.001	1.01(0.97-1.05)	0.663
Gender	Male	1.47(0.75-2.9)	0.261	-	-
	Female	Ref		-	-
Occupation	Driver	2.36(0.61-9.16)	0.216	-	-
	Tailor	0.59(0.07-5.18)	0.633	-	-
	Office worker	0.69(0.17-2.75)	0.600	-	-
	Fisher man	1.45(0.34-6.13)	0.617	-	-
	Motor mechanic	0.8(0.2-3.19)	0.746	-	-
	Factory worker	0.44(0.05-3.79)	0.456	-	-
	Daily wage labor	1.47(0.62-3.45)	0.378	-	-
	Operation theatre technician	2.36(0.61-9.16)	0.216	-	-
	Housemaid	1.06(0.11-10.07)	0.960	-	-
	Electrician	1.06(0.11-10.07)	0.960	-	-
	Housewife	Ref		-	-
Injury mechanism	Trauma	1.04(0.36-2.99)	0.948	-	-
	Boil	1.80(0.54-6.03)	0.34	-	-
	Animal bite	2.48(0.48-12.97)	0.280	-	-
	Human bite	5.80(0.66-51.19)	0.114	-	-
	Insect bite	1.93(0.44-8.47)	0.382	-	-
	Foreign bite	1.11(0.26-4.62)	0.891	-	-
	Burn	1.29(0.21-7.82)	0.783	-	-
		Idiopathic	Ref		-
Comorbidity	Chronic kidney disease	6.46(1.40-29.86)	*0.017	10.95(1.40-85.41)	*0.022
	Diabetes	4.63(2.05-10.43)	**<0.001	3.33(1-11.02)	*0.049
Smoking status	Smoker	1.86(0.77-4.48)	0.168	1.13(0.28-4.60)	0.869
	Non-smoker	Ref		Ref	
Injury type	Superficial	0.3(0.16-0.56)	**<0.001	0.57(0.23-1.43)	0.229
	Deep	Ref			
Dominant hand involved	Yes	0.92(0.45-1.85)	0.811	-	-
	No	Ref			
Total affected sites	Single site	Ref			
	More than one site	19.59(6.05-63.43)	**<0.001	2.89(0.60-13.92)	0.187
Culture growth	Negative	0.18(0.04-0.78)	*0.021	0.90(0.18-4.43)	0.899
	Positive	Ref			
	TLC	1.85(1.52-2.24)	**<0.001	1.60(1.27-2.01)	**<0.001
	ESR	1.11(1.07-1.16)	**<0.001	1.05(1.02-1.09)	**0.006
	CRP	1.08(1.04-1.13)	**<0.001	0.98(0.92-1.05)	0.596

CI: Confidence interval, CRP: C-reactive protein, TLC: total leukocyte count, ESR: Erythrocyte sedimentation rate, OR: Odds ratio, aOR: Adjusted odds ratio, Ref: Reference category, *Significant at p<0.05, **Significant at p<0.01

activities and labor working job nature which make them more vulnerable to acquire traumatic hand injuries.

Most of the hand infections were caused among daily wage labors followed by house wife and motor mechanics and tailors. A Pakistani survey also reported that majority of the hand injuries occurred among unskilled workers (66%).¹³ It has been also reported in other Pakistani survey that majority of the affected group were unskilled labors (71.5%).¹² Carpenters, students, manual laborers, and manufacturing employees were shown to be the top four jobs most

at risk for hand injuries, according to research by Sharma et al. Most accidents happened in woodworking and furniture factories.¹⁶ Abebe conducted a study in Ethiopia and found that mechanism of majority of the hand injuries was home accidents and fall.¹⁵ Hand injuries leading infections among house wife could be possible while working in kitchen involved in cooking food and cutting vegetables and during home cleaning.

In our patients, more than three-fourth patients had positive culture growth (83.7%). In contrast to our study, other investigations reported lower positivity

rate of 48%,¹¹ 66.1%,¹⁷ 68%,⁶ and 73%.¹⁸ On the other hand, Vyver and his co-investigator reported a higher positive rate of 96.7%.¹⁴ Fuchsjäger et al observed no growth in among 0.5% cases of the total tested for culture susceptibility.¹⁹ The most frequently detected causative pathogen in our study was *Staphylococcus aureus* including cases of methicillin-sensitive *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus aureus* (MRSA). Many of the researchers demonstrated in their study that *Staphylococcus aureus* was the commonest detected microorganism among hand infections.^{6,11,19,20} Moreover, our analysis revealed that detection rate of all other pathogens was even lower than one-tenth of the total which is also consistent findings with similar existing literature.^{6,11,18} However, Fuchsjäger et al¹⁹ identified that Coagulase-negative staphylococci was positive in nearly one-fifth of the total investigated specimens, which is in disagreement to our findings. The difference in positivity rate and distribution of causative pathogens is possible because different environment and patients' related characteristics.

The present study analyzed that approximately one-fifth of the sample underwent reoperation. Verhoef and coauthors observed in their investigation that 30% of patients developed any complication after initial management of hand infection whereas 18% underwent re-debridement.⁶ Werner et al investigating factors associated with reoperation, analyzed 369 patients with primary hand infections and reported that 21.7% patients needed more than one operation.¹¹ Botma et al from South Africa retrospectively studied records of 652 patients presenting with primary hand infections and found that 11% of them underwent revision of surgery.²¹

The coexistence of other diseases negatively impacts the patients' outcome and we also found this influence in this study. Patients with coexisting disease of chronic kidney diseases and diabetes were at higher risk to undergo re-surgery. Chronic kidney diseases are linked to immune activity. The weaker immunity in kidney diseases is responsible for slow recovery and poor patient's outcome. Existence of diabetes complicates the disease course due to which wound healing slows down than

non-diabetic patients. Many other researchers also reported diabetes as risk factor of reoperation in primary hand infection.^{6,21} Surprisingly, Werner et al did not find diabetes association with reoperation.¹¹ Increasing total leukocytes count and erythrocyte sedimentation rate were also identified as significant predictors of reoperation in this study. Werner et al also reported elevated TLC and CRP levels, multiple injuries and positive culture growth as risk factor of reoperation. However, increasing CRP levels and multiple injuries were associated with reoperation in univariate analysis, in our study. These factors were no longer significant on multivariable analysis when model was adjusted for other covariates, most likely because of strong effect of other variables on reoperation than these two variables. Although, presence of multiple injuries and raised CRP levels in our study were not significant in this study, reconstructive surgeons still need to be cautious in cases of multiple injuries for avoiding revision of surgery in future. Moreover, inflammation and infection markers should be investigated in scheduled follow-up visits for vigilant surveillance of high risk cases for monitoring of culture growth and prevent surgery revision.

LIMITATIONS OF THE STUDY

The present study was a single center experience from a public sector tertiary care hospital with a limited number of study subjects, due to which the study findings cannot be generalized to the entire Pakistani population. In this study, sensitivity pattern of causative pathogens was not studied as the study main focus was on reoperation rate. However, knowing the sensitivity pattern would be helpful in determining useful antibiotics which could be the factor to avoid reoperation event. Moreover, we also did not inquire educational status of patients as we thought that it is not necessary. Future multi-center investigation may be conducted with larger sample size to address the gap of the existing study and study pattern of primary hand infection and their outcomes.

CONCLUSION

The present study analyzed that a considerable number of patients

underwent reoperation. Chronic kidney disease, diabetes, increasing total leukocyte count and erythrocyte sedimentation rate at the time of presentation were significant predictors of reoperation.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

US: Concept and study design, acquisition of data, drafting the manuscript, approval of the final version to be published

SK & SR: Acquisition of data, drafting the manuscript, approval of the final version to be published

HI & WS: Study design, analysis and interpretation of data, critical review, approval of the final version to be published

SS: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request



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