

# Characteristics of Inpatients with Distal Phalangeal Injuries: Predictors of Long Term Hospitalization

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**Purpose:** Distal phalangeal injury is one of the most common hand injuries. Distal phalanx is very small area, but in the patients who injure in this area, hospitalization is often necessary. Some of the patients need the long hospital stay for three or more weeks. Assessment of trends of the injuries may help in enhancing patient education and designing the management plan. We analyzed the characteristics of inpatients with distal phalangeal injuries and the predictors of long-term hospitalization.

**Methods:** A retrospective review of inpatients with distal phalangeal injuries was performed consecutively from June 2008 to July 2015. Patient demographics and outcomes were compared with chi-squared analysis and Student's t-test. Using multivariate regression analysis, predictors of long-term hospitalization were identified.

**Results:** Five hundred and twelve patients were investigated. The rate of long-term hospitalization was 21.9%. Multivariate logistic regression model revealed that diabetes mellitus, operation time of three or more hours, amputation injury, injury sustained at an industrial place, complication, distant flaps, and replantation were significant risk factors of long-term hospitalization.

**Conclusion:** This analysis will help evaluate the possibility of long-term hospitalization and manage patients with distal phalangeal injuries.

**Keywords:** Finger injuries, Length of stay, Risk factors

## INTRODUCTION

Distal phalangeal injuries are one of the most common hand injuries<sup>1</sup>. The area is small, but it is a functionally and aesthetically important region. This limited area has some unique structures such as the nail plate, nail bed, distal phalangeal bone, pulp, insertion sites of the flexor

and extensor tendons, and neurovascular structures.

In most cases, the patients can be sufficiently treated in the emergency room without hospitalization. In more severe cases such as mutilated and multiple injuries, hospitalization is often necessary. But it is not easy to be accepted because the injured area is too small. Especially the necessity of long term hospitalization is underesti-

**Table 1.** The investigated variables

Classification	Variables
Patient demographics	Sex, age, smoking, diabetes mellitus, hypertension
Injury profiles	Cause, type of injury, location, number, injury place, injury time, terminal tendon injury, distal phalangeal fracture, nail structure injury, time to hospital
Perioperative details	Laboratory values (white blood cell, hemoglobin, C-reactive protein, hemoglobin A1c), anesthesia, operation time, reconstructive techniques, postoperative complications
Others	Occupation, education status

mated. Therefore, we want to know characteristics of the inpatient who has long hospital stay due to distal phalangeal injuries.

## MATERIALS AND METHODS

A retrospective chart review was performed on 563 patients who were hospitalized due to distal phalangeal injuries from June 2008 to July 2015. The patients who also had injuries at the proximal region of the distal phalanx were excluded. 51 patients with incomplete data were excluded.

The major research parameter was the rate of long-term hospitalization. Long-term hospitalization was defined as "Hospitalization for three or more weeks". The period was referred to the textbook that immobilization period for 2 or 3 weeks was needed if primary surgery was distant flap such as groin flap<sup>2</sup>. In addition, the period was referred to other study about inpatients with non-fatal occupational injury<sup>3</sup>.

Twenty two variables including patient demographics, injury profiles, and perioperative details were investigated (Table 1). The variables were assessed through frequency analysis. Multivariate logistic regression models were used for identifying risk factors of long-term hospitalization. Hosmer-Lemeshow tests for calibration were used to assess the goodness of fit of the model. All analyses were conducted using PASW ver. 18.0 (SPSS Inc., Chicago, IL, USA). Probability values of less than 0.05 were considered statistically significant.

## RESULTS

A total of 512 patients were evaluated. Mean hospitaliza-

**Table 2.** Postoperative complications

Complication	No. (%)
Total	68 (13.3)
Partial necrosis of flap or skin graft	29 (42.6)
Total necrosis of flap or skin graft	10 (14.7)
Wound dehiscence	17 (25.0)
Surgical site infection	12 (17.6)

**Table 3.** Frequency of complications

	Number	Complication
Type of injury		
Crushing	196	18 (9.2)
Laceration	136	9 (6.6)
Avulsion	32	2 (6.3)
Amputation	148	39 (26.4)
Primary surgery		
Skin grafts	65	7 (10.8)
Local flaps	382	40 (10.5)
Distant flaps	43	7 (16.3)
Replantation	22	14 (63.6)

Values are presented as number (%).

tion period was 10.8 days. Among them, one hundred twelve (21.9%) patients needed long-term hospitalization for three or more weeks.

Sixty-eight (13.3%) patients had postoperative complications. The most common complication was partial necrosis of the flap or skin graft (42.6%). Other surgical complications included total necrosis of the flap or skin graft, wound dehiscence, and surgical site infection (Table 2). In type of injury, amputation showed the highest complication rate. And in primary surgery, replantation showed the highest rate (Table 3).

A total of ten variables were significantly related to long-term hospitalization. They were amputation injury,

**Table 4.** Characteristics of inpatients with distal phalangeal injuries

Demographics	Short term hospitalization (under 3 wk)	Long term Hospitalization (3 wk or more)	p-value
No. of patients	400	112	
Sex			
Male	309 (78.6)	84 (21.4)	0.982
Female	91 (76.5)	28 (23.5)	0.974
Age			
<20	44 (91.7)	4 (8.3)	0.997
20–40	112 (80.0)	28 (20.0)	0.994
40–60	192 (76.7)	65 (25.3)	0.134
>60	52 (77.6)	15 (22.4)	0.981
Hand			
Left	195 (79.3)	51 (20.74)	0.407
Right	205 (77.1)	61 (22.9)	0.395
No. of fingers			
One	341 (79.9)	86 (20.1)	0.914
Two	34 (65.4)	18 (34.6)	0.334
Three	16 (72.7)	6 (27.3)	0.882
Four	9 (81.8)	2 (18.2)	0.992
Location			
Thumb	71 (82.6)	15 (17.4)	0.993
Index	132 (74.6)	45 (25.4)	0.52
Middle	88 (74.6)	30 (25.4)	0.617
Ring	65 (86.7)	10 (13.3)	0.997
Little	44 (78.6)	12 (21.4)	0.988
Type of injury			
Crushing	166 (84.7)	30 (15.3)	0.952
Laceration	118 (86.8)	18 (13.2)	0.975
Avulsion	26 (81.3)	6 (18.7)	0.924
Amputation	90 (60.8)	58 (39.2)	<0.001 <sup>a)</sup>
Distal phalangeal fracture			0.045 <sup>a)</sup>
No	290 (80.8)	69 (19.2)	
Yes	110 (71.9)	43 (28.1)	
Terminal tendon injury			
No	248 (72.3)	95 (27.7)	0.172
Yes	152 (89.9)	17 (10.1)	
Nail structure injury			0.128
No	301 (80.9)	71 (19.1)	
Yes	99 (70.7)	41 (29.3)	
Diabetes mellitus			0.007 <sup>a)</sup>
No	381 (79.4)	99 (20.6)	
Yes	19 (59.4)	13 (40.6)	
Hypertension			0.251
No	352 (77.2)	104 (22.8)	
Yes	48 (85.7)	8 (14.3)	
Smoking			0.041 <sup>a)</sup>
No	237 (78.5)	65 (21.5)	
Yes	163 (77.6)	47 (22.4)	

(Continued to the next page)

Table 4. Continued

Demographics	Short term hospitalization (under 3 wk)	Long term Hospitalization (3 wk or more)	p-value
Anesthesia			
Local	354 (78.3)	98 (21.7)	0.879
Regional	31 (77.5)	9 (22.5)	0.348
General	15 (75.0)	5 (25.0)	0.047 <sup>a)</sup>
Primary surgery			
Skin grafts	55 (84.6)	10 (15.4)	0.912
Local flaps	327 (85.6)	55 (14.4)	0.934
Distant flaps	9 (20.9)	34 (79.1)	<0.001 <sup>a)</sup>
Replantation	9 (40.9)	13 (59.1)	<0.001 <sup>a)</sup>
Operation time			
<1 hr	236 (89.7)	27 (10.3)	0.995
1–3 hr	147 (68.4)	68 (31.6)	0.073
>3 hr	17 (50.0)	17 (50.0)	<0.001 <sup>a)</sup>
Wound complication			<0.001 <sup>a)</sup>
No	375 (84.5)	69 (15.5)	
Yes	25 (36.8)	43 (63.2)	
Partial necrosis	5 (17.2)	24 (82.8)	
Total necrosis	0	10 (100)	
Dehiscence	13 (76.5)	4 (23.5)	
Surgical site infection	7 (58.3)	5 (41.7)	
Education			0.879
No/Obligation	195 (78.3)	54 (21.7)	
High	205 (77.9)	58 (22.1)	
Injury place			
Farm	74 (77.9)	21 (22.1)	0.892
Industrial place	164 (68.3)	76 (31.7)	0.031 <sup>a)</sup>
Residence	162 (91.5)	15 (8.5)	0.927
Injury time			
0:00–6:00	37 (94.9)	2 (5.1)	0.998
6:00–12:00	113 (80.1)	28 (19.9)	0.917
12:00–18:00	144 (71.3)	58 (28.7)	0.162
18:00–24:00	106 (81.5)	24 (18.5)	0.934
Time to hospital			
<0.5 hr	263 (76.0)	83 (24.0)	0.617
0.5–2 hr	108 (81.2)	25 (18.8)	0.945
>2 hr	29 (87.9)	4 (12.1)	0.981

Values are presented as number (%).

<sup>a)</sup>Significant difference,  $p < 0.05$ .

distal phalangeal bony fracture, smoking, general anesthesia, treatment with distant flaps, treatment with replantation, operation time of three or more hours, complication, diabetes mellitus (DM), and injury sustained at an industrial place (Table 4). In the multivariate logistic regression analysis, the following seven significant predictors of long-term hospitalization for distal phalangeal

injuries were identified: DM, operation time of three or more hours, amputation injury, injury sustained at an industrial place, complication, treatment with distant flaps, and treatment with replantation (Table 5). Distant flaps had the highest risk of long-term hospitalization (odds ratio [OR], 19.609; 95% confidence interval [CI], 7.611–50.518;  $p < 0.001$ ), followed by complication (OR,

**Table 5.** The associated factors of long-term hospitalization on multivariate regression

Variable	Odds ratio	95% Confidence interval	p-value
Amputation injury	3.494	1.382–8.830	0.008 <sup>a)</sup>
Distal phalangeal fracture	1.094	0.523–2.287	0.811
Diabetes	4.410	1.195–6.276	0.026 <sup>a)</sup>
Uncontrolled (hemoglobin A1c >10.0%)	1.559	0.002–8.691	0.543
Smoking	1.200	0.546–2.636	0.650
General anesthesia	0.477	0.133–1.716	0.257
Primary surgery			
Distant flap	19.609	7.611–50.518	<0.001 <sup>a)</sup>
Replantation	6.045	2.079–17.582	0.001 <sup>a)</sup>
Operation for >3 hr	5.264	1.617–7.134	0.006 <sup>a)</sup>
Wound complication (necrosis of skin graft of flap)	7.297	3.266–16.300	<0.001 <sup>a)</sup>
Injury at industrial place	2.969	1.556–5.663	0.001 <sup>a)</sup>

Hosmer–Lemeshow statistic, 0.833.

<sup>a)</sup>Significant difference,  $p < 0.05$ .

7.297; CI, 3.266–16.300;  $p < 0.001$ ), treatment with replantation (OR, 6.045; CI, 2.079–17.582;  $p = 0.001$ ), operation time of three or more hours (OR, 5.264; CI, 1.617–7.134;  $p = 0.006$ ), DM (OR, 4.410; CI, 1.195–6.276;  $p = 0.026$ ), amputation injury (OR, 3.494; CI, 1.382–8.830;  $p = 0.008$ ), and injury sustained at an industrial place (OR, 2.969; CI, 1.556–5.663;  $p = 0.001$ ). The p-value of Hosmer–Lemeshow test computed for the multivariate logistic regression was 0.833, implying that the estimates of the regression model fit the data at an acceptable level.

## DISCUSSION

Distal phalanx is a functionally and aesthetically important region. But hospitalization for the injury of this small area is not easy to be accepted. And the long term hospitalization is more difficult to be accepted. A detailed analysis of inpatients with distal phalangeal injuries is needed to help identify the patients with the possibility of long-term hospitalization and aid in identifying the significant associated factors of prolonged hospitalization.

On multivariate regression model analysis, treatment with distant flap was found to be the most important relating factor. In case of distant flap, the flap usually requires an attachment period of 2–3 weeks. Therefore,

the surgical procedure itself induces a prolonged hospital stay. Treatment with replantation was also a quite relevant factor. In this area, vessels and nerves are very small. Especially, in Tamai zone 1, the diameter of central artery is about 0.5 mm<sup>4</sup>. Therefore, replantation of distal phalanx is very challenging. Additionally, in many case, the cut vessels and nerves were crushed and avulsed. Hence, the postoperative complications such as partial or complete necrosis might tend to occur<sup>5</sup>. In this group, 63.6% had complications (Table 3).

Complication was identified as the second important relating factor for long-term hospitalization. Among the patients with complications, 63.2% of the patients belonged to the long-term hospitalization group. In long term hospitalization group, the rates of partial or total necrosis of graft or flap increased. These patients might need an unexpected hospitalization for additional procedures or secondary intention with administration of intravenous antibiotics<sup>6</sup>.

Thirty-four patients underwent reconstructive operation for three or more hours. Among them, 50% of the patients belonged to the long-term hospitalization group. The prolonged operation time itself may increase tissue trauma and pathogen exposure. Hence, it induces soft tissue infections<sup>7</sup>. In this group, 54.5% had wound com-

plications. Among their complications, surgical site infection counted for 33.3%.

Thirty-two patients had DM. Among them, 40.6% of the patients were hospitalized for three or more weeks. DM is a well-known risk factor for delayed wound healing and unexpected infection<sup>8</sup>. They might need the period for delayed wound healing and management of other medical problems rather than solving the wound complications. We expected that the uncontrolled DM group (hemoglobin A1c>10.0% group) might have a higher risk of long-term hospitalization than the controlled DM group<sup>9</sup>. The uncontrolled DM group had about 1.5 times higher risk than the controlled DM group, but there was no significant difference in this study ( $p=0.543$ ).

In long term hospitalization group, amputation injury was most common type. In this area, the diameters of vessels are too small and soft tissues are various and unique. Although replantation was performed in only 14.9% of patient with amputation injury, the repair must be performed in accordance with the characteristics of these structures<sup>10</sup>. Therefore, the injury prolonged the operation time or increased the risk of complications. In this group, 26.4% had complications (Table 3).

Injury sustained at an industrial place was also identified as a significant risk factor. In an industrial place, the most common cause of injury was the use of heavy equipment such as compressor, belt, and electric saw. Thus, this might have led to mutilated injuries. But in this group, 31.9% had amputation and 35.6% had distal phalangeal fracture. The values indicate that about 70% patients had long hospital stay without mutilated injuries. So it seems that the rates of the patients with mutilated injuries are insufficient to explain the long hospital stay. The accompanying sociopsychological compensation can also be another factor.

Our study leaves something to desired. First, we tried to consider all factors such as the medical factors as well as the social factors for long-term hospitalization. But, all factors could not be considered due to limited social and psychological information in the electronic medical records. In other study, these factors can affect hospitalization period considerably<sup>11</sup>. Especially in case of indus-

trial injuries, the possibility that the patients themselves wanted to stay longer in the hospital for secondary gains could not be ruled out. And if patients and surgeons are nervous, the length of hospital stay may be prolonged. The other way, the lack of rapport with the patients can shorten the length of hospital stay regardless of medical necessity.

Second, it seems that there were correlations between some variables such as DM and wound complications, injury type and primary surgery, primary surgery and anesthesia, etc. But in DM group, complications rate was only 14.3%. There was no statistically significant correlation between DM and complication. And in patients with amputation injury, replantation was considered as primary surgery. But, in many case, stump revision was performed as the patient's request. In this study, only 22 of 148 inpatient with amputation injury underwent replantation. In case of the nervous patients, local flap was performed under general anesthesia.

## CONCLUSION

In patients with distal phalangeal injuries, the necessity of long term hospitalization is not easy to be understood. But the long term hospitalization is needed in accordance with type of injury, primary surgical method, or clinical course. In our study, DM, operation time of three or more hours, amputation injury, injury sustained at an industrial place, complication, distant flaps, and replantation were found to be significant risk factors of long-term hospitalization. Understanding these characteristics of the patients it will help in enhancing patient education and designing the management plan in the inpatients with distal phalangeal injuries.

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# 말단지부손상으로 입원한 환자의 특징과 장기입원 위험인자

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**목적:** 말단수지손상의 가장 흔한 수부 손상 중 하나로 매우 작은 부위지만 입원치료가 필요한 경우가 있으며 일부는 3주 이상의 장기입원을 하는 경우도 있다. 이런 손상의 경향을 평가하는 것은 환자의 상태를 설명하고 관리하는데 도움을 줄 것이다. 말단수지손상으로 입원한 환자의 특징을 파악하고 장기입원의 위험인자를 알고자 하였다.

**방법:** 2008년 6월에서 2015년 7월까지 차트 분석을 시행하였고 환자 자료는 카이 제곱 분석과 t-test를 이용하여 분석하였다. 다중회귀분석으로 장기입원에 대한 예측변수를 분석하였다.

**결과:** 512명의 환자가 조사되었고 장기입원율은 21.9%로 나타났다. 다중회귀모델에서 당뇨, 3시간 이상의 수술, 절단 손상, 산업장소에서 손상, 합병증, 원거리피판수술, 재접합수술이 유의한 장기입원의 위험인자로 드러났다.

**결론:** 이런 연구 결과를 바탕으로 말단수지손상으로 입원 시 장기입원에 대한 가능성을 평가하고 관리 계획을 세우는 데 도움을 줄 수 있을 것으로 생각된다.

**색인단어:** 손가락 손상, 입원기간, 위험인자

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