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Clinical outcomes and factors associated with failure after digital replantation: A retrospective cohort study

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Abstract

Traumatic digital amputation may result in substantial functional impairment, and the outcome of digital replantation is influenced by both patient- and injury-related factors. This study aimed to evaluate clinical outcomes after digital replantation, identify factors independently associated with replantation failure, and assess the discriminative performance of the Mangled Extremity Severity Score (MESS). This retrospective observational study included adult patients who underwent digital replantation after traumatic digital amputation between July 2022 and July 2024. Replantation outcome was assessed at one month, with the patient used as the unit of analysis. Demographic characteristics, comorbidities, injury mechanism, treatment intervals, and MESS were evaluated. Factors independently associated with replantation failure were assessed using multivariable binary logistic regression. The discriminative performance of MESS was evaluated using receiver operating characteristic (ROC) curve analysis. Of 312 patients screened, 223 were included in the final analysis. Replantation was successful in 171 patients (76.7%), whereas 52 (23.3%) experienced failure. In multivariable analysis, smoking (adjusted odds ratio (aOR) 25.013, 95% confidence interval (CI) 3.562 – 175.626; p = 0.001), diabetes mellitus (aOR 197.818, 95% CI 13.886 – 2818.088; p < 0.001), hypertension (aOR 12.981, 95% CI 2.390 – 70.510; p = 0.003), and injury mechanism (overall p < 0.001) were independently associated with replantation failure. Very-high-energy injury was associated with higher odds of failure compared with low-energy injury (aOR 140.282, 95% CI 9.070 – 2169.651; p < 0.001). Age, sex, and hospital arrival-to-replantation interval were not independently associated with failure. MESS demonstrated good discrimination for replantation failure (area under the curve (AUC) 0.846, 95% CI 0.783 – 0.910; p < 0.001). An exploratory MESS cutoff of ≥ 5 yielded 80.8% sensitivity and 78.9% specificity. Digital replantation was successful at one month in approximately three-quarters of patients. Smoking, diabetes mellitus, hypertension, and injury mechanism were independently associated with replantation failure. MESS showed good discrimination for failure; however, the identified cutoff should be considered exploratory and requires external validation.

Keywords: Amputation, traumatic; finger injuries; microsurgery; replantation; risk factors; treatment failure

Introduction

Traumatic digital amputation is a potentially disabling injury with substantial consequences for hand function, quality of life, and return to daily and occupational activities. When technically feasible, microsurgical replantation offers the possibility of preserving the native digit and restoring useful hand function. A systematic review of distal digital replantation reported an overall survival rate of approximately 86%, together with favorable sensory and functional outcomes [1]. Moreover, the multicenter international FRANCHISE study demonstrated better patient-reported outcomes after replantation than after revision amputation for selected patterns of traumatic digital amputation [2].

Despite advances in microsurgical techniques, successful replantation remains difficult to predict. Outcomes are influenced by a complex interaction between patient-related characteristics, injury severity, mechanism of injury, ischemic conditions, and technical factors. A quantitative review including more than 6,000 digital replantations identified injury mechanism and the number of arterial and venous anastomoses as factors associated with replant survival, whereas associations with age, sex, tobacco use, and ischemia time were less consistent across studies [3].

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Similarly, previous meta-analytic evidence has suggested poorer survival after crush and avulsion injuries than after clean-cut amputations [4]. These findings emphasize the importance of injury characteristics while also illustrating the heterogeneity of reported prognostic factors.

Evaluation of replantation outcome is further complicated by variability in outcome definitions and assessment methods. A systematic review of observational studies identified substantial heterogeneity in both outcomes and outcome measures used after digital replantation, with digit survival, sensation, and hospitalization-related measures among the most frequently reported outcomes [5]. Functional outcome is also clinically relevant because anatomical survival alone does not necessarily imply restoration of useful hand function. A meta-analysis of functional outcomes following digital replantation demonstrated generally favorable functional recovery but also showed that outcomes may vary according to injury level and mechanism [6].

More recently, efforts have been made to develop structured approaches to severity assessment and prognostication in severe digital injuries. The Mangled Digit Severity Score (MDSS), developed specifically for mangled digital injuries, demonstrated promising discrimination between salvaged and amputated digits, although further external validation is required [7]. Nevertheless, evidence remains limited regarding how readily available patient characteristics, injury severity, and early clinical variables jointly relate to short-term replantation outcomes in routine clinical practice.

Therefore, the present study aimed to evaluate the clinical outcomes of patients undergoing digital replantation after traumatic digital amputation and to identify factors independently associated with replantation failure. In addition, we evaluated the discriminative performance of the Mangled Extremity Severity Score (MESS) for replantation failure in this cohort.

Material and Methods

Study Design and Setting

This retrospective observational study was conducted in the emergency department of a tertiary referral center. Patients presenting with traumatic digital amputation between July 2022 and July 2024 were evaluated. Clinical data were retrospectively obtained from the institutional electronic medical record system. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [8].

This study was approved by the Başkent University Non-Interventional Clinical Research Ethics Committee (Project No: KA24/332; Decision No: 26/223; Date: 02.07.2026) and supported by the Başkent University Research Fund. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Study Population and Patient Selection

Adult patients (≥ 18 years) who presented with traumatic digital amputation during the study period and underwent digital replantation were eligible for inclusion. A total of 312 patients presenting with traumatic digital amputation were screened for eligibility. Thirty-seven patients with injuries considered too severe for replantation were excluded. An additional 21 patients who refused treatment and left the institution and 31 patients whose medical records could not be retrieved were excluded. Consequently, 223 patients who underwent digital replantation and had sufficient clinical and one-month follow-up data for outcome assessment were included in the final analysis (Figure 1).

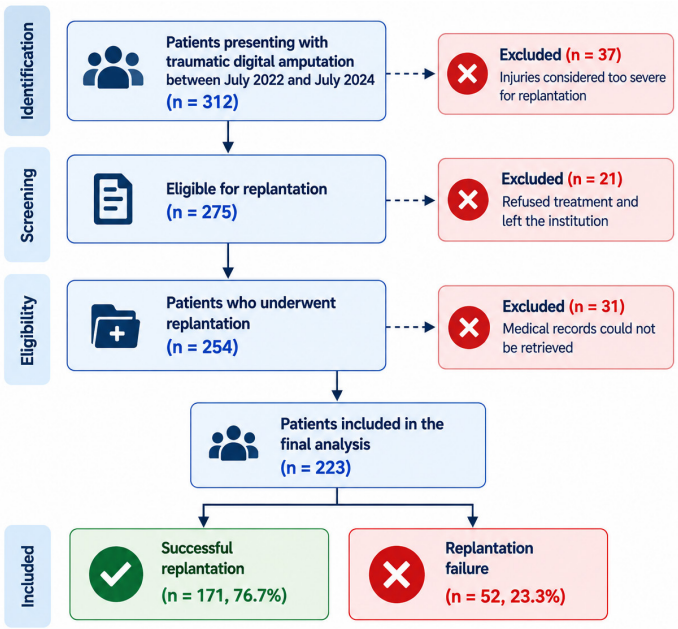


Figure 1. Flow diagram of patient selection. Values are presented as number (percentage).

All eligible patients meeting the study criteria during the predefined study period were included. Therefore, no a priori sample size calculation was performed.

Data Collection and Clinical Variables

Demographic, clinical, injury-related, treatment-related, and outcome data were retrospectively obtained from electronic medical records. The variables evaluated included age, sex, smoking status, alcohol use, diabetes mellitus, hypertension, hypotension, injury mechanism, MESS, time from injury to hospital arrival, time from injury to initiation of replantation, and time from hospital arrival to initiation of replantation.

MESS, originally developed as an objective severity assessment tool for severely injured extremities, incorporates skeletal/soft-tissue injury, limb ischemia, shock, and patient age [9]. The mechanism/severity of injury was categorized according to the skeletal/soft-tissue injury component of MESS as low-, medium-, high-, or very-high-energy trauma [9]. Low-energy injuries included stab injuries, gunshot injuries, and simple

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fractures; medium-energy injuries included dislocations and open or multiple fractures; high-energy injuries included high-speed motor vehicle accidents or rifle-shot injuries; and very-high-energy injuries included high-speed trauma associated with gross contamination.

The injury-to-hospital arrival interval was defined as the time between the traumatic event and hospital presentation. The injury-to-replantation interval was defined as the time between the traumatic event and initiation of the replantation procedure, whereas the hospital arrival-to-replantation interval was defined as the time between hospital presentation and initiation of replantation. Exact warm and cold ischemia durations could not be reliably determined from the retrospective medical records and were therefore not included in the analysis.

Postoperative complications recorded during follow-up included infection, vascular crisis/thrombosis, and necrosis. These complications were not mutually exclusive, and more than one complication could occur in the same patient.

Outcome Definition and Follow-up

The primary outcome was replantation success at the one-month follow-up. Replantation was considered successful when the replanted digit remained viable without requiring subsequent amputation during the one-month follow-up period. Replantation failure was defined as loss of viability of the replanted digit resulting in complete necrosis and/or subsequent amputation within the same follow-up period. A minimum follow-up duration of one month was required for outcome assessment.

The patient was used as the unit of analysis. In patients who underwent replantation of multiple digits, the patient-level outcome was classified as failure if at least one replanted digit failed. Accordingly, a patient was classified as having a successful outcome only when all replanted digits met the criteria for replantation success.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality and, because their distributions were non-normal, were summarized as median and interquartile range (IQR). Comparisons of continuous variables between the successful and failed replantation groups were performed using the Mann – Whitney U test. Categorical variables were presented as numbers and percentages and compared using Pearson's chi-square test or Fisher's exact test, as appropriate.

A multivariable binary logistic regression model was constructed to identify factors independently associated with replantation failure. Replantation failure was coded as the event (failure = 1; success = 0). Age, sex, smoking status, diabetes mellitus, hypertension, injury mechanism, and hospital arrival-to-replantation interval were entered simultaneously into the model. Covariates for the multivariable model were selected based on their clinical relevance to replantation outcome while limiting model complexity in view of the number of failure events. Hypotension was not entered as an additional covariate because it reflects injury severity and hemodynamic compromise, which are also represented within the MESS framework. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported. Male sex, absence of the respective exposure or comorbidity, and low-energy injury were used as reference categories, as applicable. Model calibration was assessed using the Hosmer – Lemeshow goodness-of-fit test.

Because MESS incorporates injury-severity information that overlaps with characteristics represented by injury mechanism, it was not entered simultaneously with injury mechanism in the primary multivariable model. Instead, the discriminative ability of MESS for replantation failure was evaluated separately using receiver operating characteristic (ROC) curve analysis. The area under the ROC curve (AUC) with its 95% CI was calculated. The cutoff providing the best balance between sensitivity and specificity was explored using the Youden index. Because the cutoff was derived and evaluated within the same cohort, it was considered exploratory and was not interpreted as a validated clinical decision threshold. There were no missing data for the variables included in the analyses; therefore, no imputation was performed.

All statistical tests were two-sided, and a p value < 0.05 was considered statistically significant.

Results

Patient Selection and Replantation Outcomes

A total of 312 patients presenting with traumatic digital amputation were screened during the study period. Of these, 89 were excluded: 37 had injuries considered too severe for replantation, 21 refused treatment and left the institution, and the medical records of 31 patients could not be retrieved. The final study population therefore comprised 223 patients who underwent digital replantation and had sufficient clinical and one-month follow-up data for outcome assessment (Figure 1).

At the one-month follow-up, replantation was successful in 171 patients (76.7%), whereas 52 patients (23.3%) were classified as having replantation failure.

Clinical and Injury Characteristics According to Replantation Outcome

The median age was 27 years (IQR, 22 – 45) in the successful replantation group and 31.5 years (IQR, 24.25 – 50.75) in the failure group, with no statistically significant difference between the groups ($p = 0.063$). Male patients accounted for 82.5% of the successful group and 92.3% of the failure group; sex was not significantly associated with replantation outcome ($p = 0.084$).

Smoking was more frequent in the failure group than in the successful group (92.3% vs. 33.9%, $p < 0.001$). Similarly, diabetes mellitus (44.2% vs. 1.2%), hypertension (86.5% vs. 25.1%), alcohol use (57.7% vs. 12.9%), and hypotension (48.1%

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vs. 8.2%) were more frequent among patients with replantation failure (all $p < 0.001$).

Injury mechanism also differed significantly between the two outcome groups ($p < 0.001$). Low- and medium-energy injuries predominated among successful replantations, whereas high- and very-high-energy injuries were more frequent in the failure group (Table 1).

No significant between-group differences were observed in the injury-to-hospital arrival interval, injury-to-replantation interval, or hospital arrival-to-replantation interval ($p = 0.622$, $p = 0.423$, and $p = 0.447$, respectively). In contrast, MESS was significantly higher among patients with replantation failure than among those with successful replantation ($p < 0.001$) (Table 1).

Table 1. Baseline clinical and injury characteristics according to replantation outcome

Variable	Successful replantation (n = 171)	Replantation failure (n = 52)	p value
Age, years	27 (22 – 45)	31.5 (24.25 – 50.75)	0.063
Sex			0.084
Male	141 (82.5)	48 (92.3)	
Female	30 (17.5)	4 (7.7)	
Smoking	58 (33.9)	48 (92.3)	**< 0.001**
Diabetes mellitus	2 (1.2)	23 (44.2)	**< 0.001**
Hypertension	43 (25.1)	45 (86.5)	**< 0.001**
Alcohol use	22 (12.9)	30 (57.7)	**< 0.001**
Hypotension	14 (8.2)	25 (48.1)	**< 0.001**
Injury mechanism			**< 0.001**
Low energy	40 (23.4)	5 (9.6)	
Medium energy	108 (63.2)	5 (9.6)	
High energy	16 (9.4)	21 (40.4)	
Very high energy	7 (4.1)	21 (40.4)	
Injury-to-hospital arrival interval, min	27 (17 – 36)	26 (18 – 37.75)	0.622
Injury-to-replantation interval, min	35 (28 – 46)	36 (28.5 – 48.5)	0.423
Hospital arrival-to-replantation interval, min	10 (9 – 11)	10 (10 – 11.75)	0.447
MESS	4 (3 – 4)	5 (5 – 6)	**< 0.001**

Data are presented as median (interquartile range) or n (%). Continuous variables were compared using the Mann – Whitney U test. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate. Abbreviations: MESS, Mangled Extremity Severity Score.

Postoperative Complications Among Patients With Replantation Failure

Among the 52 patients with replantation failure, vascular crisis/thrombosis was the most frequently recorded postoperative complication, occurring in 34 patients (65.4%). Infection was recorded in 25 patients (48.1%), and necrosis in 12 patients (23.1%). These complications were not mutually exclusive, and more than one complication could occur in the same patient (Table 2).

Table 2. Postoperative complications among patients with replantation failure

Postoperative complication	Replantation failure (n = 52), n (%)
Vascular crisis/thrombosis	34 (65.4)
Infection	25 (48.1)
Necrosis	12 (23.1)

Complications were not mutually exclusive; therefore, more than one complication could be recorded in the same patient and percentages do not sum to 100%.

Multivariable Analysis of Replantation Failure

In the multivariable binary logistic regression analysis, smoking, diabetes mellitus, hypertension, and injury mechanism remained independently associated with replantation failure after adjustment for age, sex, and the hospital arrival-to-replantation interval (Table 3).

Smoking was associated with higher odds of replantation failure (aOR 25.013, 95% CI 3.562 – 175.626; $p = 0.001$), as were diabetes mellitus (aOR 197.818, 95% CI 13.886 – 2818.088; $p < 0.001$) and hypertension (aOR 12.981, 95% CI 2.390 – 70.510; $p = 0.003$).

Injury mechanism was independently associated with replantation failure overall ($p < 0.001$). Using low-energy injury as the reference category, very-high-energy injury was associated with higher odds of failure (aOR 140.282, 95% CI 9.070 – 2169.651; $p < 0.001$). The associations for medium-energy injury (aOR 0.291, 95% CI 0.028 – 3.021; $p = 0.301$)

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and high-energy injury (aOR 7.998, 95% CI 0.894 – 71.573; p = 0.063) did not reach statistical significance.

Age (aOR 0.975, 95% CI 0.918 – 1.036; p = 0.417), female sex (aOR 0.250, 95% CI 0.019 – 3.217; p = 0.287), and hospital arrival-to-replantation interval (aOR 0.996 per minute, 95% CI 0.771 – 1.286; p = 0.975) were not independently associated with replantation failure.

The overall regression model was statistically significant (omnibus $\chi^2 = 182.460$, df = 9; p < 0.001). The Nagelkerke R^2 was 0.843, and the Hosmer – Lemeshow goodness-of-fit test showed no evidence of poor calibration ($\chi^2 = 4.317$, df = 8; p = 0.827).

Table 3. Multivariable logistic regression analysis of factors associated with replantation failure

Variable	aOR	95% CI	p value
Age, per year	0.975	0.918 – 1.036	0.417
Female sex	0.250	0.019 – 3.217	0.287
Smoking	25.013	3.562 – 175.626	**0.001**
Diabetes mellitus	197.818	13.886 – 2818.088	**< 0.001**
Hypertension	12.981	2.390 – 70.510	**0.003**
Injury mechanism			**< 0.001**
Medium energy	0.291	0.028 – 3.021	0.301
High energy	7.998	0.894 – 71.573	0.063
Very high energy	140.282	9.070 – 2169.651	**< 0.001**
Hospital arrival-to-replantation interval, per min	0.996	0.771 – 1.286	0.975

Dependent variable: replantation failure (failure = 1; success = 0). Reference categories were male sex, absence of the respective exposure or comorbidity, and low-energy injury. Injury mechanism was significant overall (Wald $\chi^2 = 25.378$, df = 3; p < 0.001). Model statistics: omnibus $\chi^2 = 182.460$, df = 9, p < 0.001; Nagelkerke $R^2 = 0.843$; Hosmer – Lemeshow $\chi^2 = 4.317$, df = 8, p = 0.827. Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

Discriminative Performance of MESS

MESS demonstrated good discrimination for replantation failure, with an AUC of 0.846 (95% CI 0.783 – 0.910; p < 0.001) (Figure 2). In an exploratory cutoff analysis, a MESS score ≥ 5 provided the best balance between sensitivity and specificity, with a sensitivity of 80.8% and specificity of 78.9% (Youden index = 0.597).

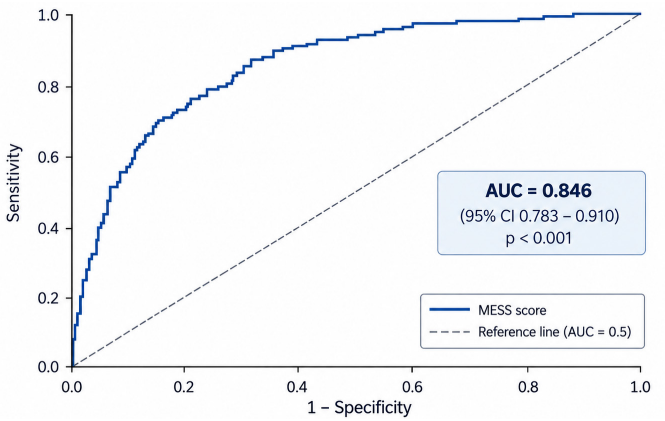


Figure 2. ROC curve of MESS for discrimination of replantation failure. The AUC was 0.846 (95% CI, 0.783-0.910; p < 0.001). At the exploratory threshold of MESS ≥ 5, sensitivity was 80.8% and specificity was 78.9%. Abbreviations: AUC, area under the curve; CI, confidence interval; MESS, Mangled Extremity Severity Score; ROC, receiver operating characteristic.

Discussion

In this retrospective cohort of patients undergoing digital replantation after traumatic digital amputation, approximately three-quarters of patients had successful replantation at one month. Replantation failure was associated with several patient- and injury-related characteristics in univariable analyses; however, after multivariable adjustment, smoking, diabetes mellitus, hypertension, and injury mechanism remained independently associated with failure. Very-high-energy injury was independently associated with replantation failure among the injury-mechanism categories. In contrast, age, sex, and the interval from hospital arrival to initiation of replantation were not independently associated with outcome. MESS also demonstrated good discrimination for replantation failure, although its role in digital injuries should be interpreted cautiously because it was not originally developed for this purpose.

The association between smoking and replantation failure observed in the present study is consistent with recent evidence suggesting an adverse relationship between smoking and digital replantation outcomes. A recent systematic review and meta-analysis found smoking to be associated with postoperative necrosis after digital replantation [10]. Earlier evidence, however, has been less consistent. A quantitative review of more than 6,000 digital replantations did not demonstrate a significant pooled association between tobacco use and replant survival [3].

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Thus, although smoking remained independently associated with failure in our cohort, the magnitude of the observed association should be interpreted cautiously. In particular, the wide confidence interval around the adjusted estimate suggests substantial imprecision and precludes interpreting the point estimate as a precise measure of individual risk.

Diabetes mellitus and hypertension were also independently associated with replantation failure in the present cohort. Patient comorbidity has previously been examined as a determinant of replantation outcome. Large observational data have suggested that increasing comorbidity burden may be associated with higher rates of replantation failure and postoperative complications, although the effects vary according to the specific comorbidity [11]. Other digital replantation cohorts have similarly evaluated diabetes and hypertension among potential prognostic factors [12]. The strong associations observed in our cohort may reflect the importance of underlying vascular and metabolic health in microsurgical outcomes; nevertheless, the particularly wide confidence interval for diabetes indicates substantial statistical uncertainty. Diabetes and hypertension should therefore be regarded as factors associated with failure in this cohort rather than isolated determinants of replantation outcome.

Injury severity and mechanism appeared to be particularly important. High- and very-high-energy injuries were disproportionately represented among patients with failure, and injury mechanism remained significant as an overall factor in the multivariable model. Very-high-energy injury was independently associated with failure compared with low-energy injury, although the estimate again had a wide confidence interval. This finding is consistent with previous evidence showing poorer outcomes after more destructive mechanisms. The quantitative review by Shaterian et al. identified injury mechanism as a significant predictor of digit survival [3], while recent meta-analytic evidence has also associated crush injury with postoperative necrosis [10]. Severe crush and avulsion mechanisms may produce tissue damage extending beyond the macroscopically apparent injury, including vascular endothelial and microcirculatory injury, thereby complicating successful reconstruction. More recent clinical evidence similarly emphasizes the importance of injury characteristics in digital replantation outcomes [13]. Collectively, these findings support considering injury severity as part of a broader clinical assessment rather than relying on any single demographic or temporal variable.

Timing is traditionally considered important in digital replantation, but time-related variables require careful interpretation. In our study, neither the injury-to-hospital interval, injury-to-replantation interval, nor hospital arrival-to-replantation interval differed significantly between successful and failed cases, and the hospital arrival-to-replantation interval was not independently associated with failure. These findings should not be interpreted as evidence that ischemia duration is unimportant. Recent meta-analytic evidence suggests that both ischemia duration and preservation conditions influence replantation survival, with appropriate cold preservation modifying the relationship between elapsed time and outcome [14]. In addition, recent evidence has associated prolonged preoperative ischemia with postoperative necrosis [10]. Earlier pooled analyses, however, have not consistently demonstrated an association between ischemia time and digit survival [3]. Importantly, our retrospective records did not permit reliable distinction between warm and cold ischemia duration or standardized documentation of preservation conditions. The temporal variables analyzed in this study therefore represent care-process intervals rather than precise measures of tissue ischemic exposure. This distinction may partly explain the absence of a significant association with outcome and limits direct comparison with studies evaluating true ischemia duration.

Vascular crisis/thrombosis was the most frequently recorded postoperative complication among patients with replantation failure, followed by infection and necrosis. These findings should be viewed descriptively because complications could overlap and the retrospective design does not establish whether a recorded complication was the primary cause, consequence, or accompanying feature of failure. Nevertheless, vascular compromise is well recognized as an important problem after digital replantation. Previous studies have identified arterial thrombosis and venous congestion among important mechanisms associated with replantation failure [15], and recent meta-analytic evidence has also demonstrated an association between thrombosis and postoperative necrosis [10]. Our findings therefore reinforce the clinical importance of postoperative vascular monitoring while avoiding causal attribution from the present retrospective data.

An additional finding of the present study was the discriminative performance of MESS. MESS yielded an AUC of 0.846 for replantation failure, and an exploratory threshold of ≥ 5 provided 80.8% sensitivity and 78.9% specificity in this cohort. These findings suggest that increasing injury severity captured by MESS contains prognostic information; however, MESS was originally developed for severely injured extremities rather than specifically for digital replantation [9]. Moreover, a recent systematic review and meta-analysis evaluating severity scoring systems in mangled upper extremities cautioned against using existing scoring systems in isolation to determine amputation or salvage decisions [16]. This limitation is particularly relevant at the digital level, where anatomical, functional, and reconstructive considerations differ from those of major limb trauma.

The recent development of the MDSS further illustrates the movement toward digit-specific prognostic assessment. In its initial study, MDSS demonstrated promising discrimination between salvaged and amputated severely injured digits [7]. Although its reported discrimination was numerically similar to that observed for MESS in our cohort, the two estimates should not be directly compared because the scores, populations, endpoints, and study designs differ. Our MESS threshold of ≥ 5

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was derived and evaluated within the same dataset and therefore should be regarded as hypothesis-generating rather than a clinical decision cutoff. External validation in independent digital replantation cohorts would be required before such a threshold could be considered for clinical application.

Several limitations should be considered when interpreting these findings. First, the retrospective, single-center design introduces the possibility of selection bias and limits generalizability. Second, although the multivariable model addressed several important confounders, residual confounding remains possible, and the relatively small number of failure events resulted in wide confidence intervals for several estimates, particularly diabetes mellitus and very-high-energy injury. These estimates should therefore be interpreted primarily in terms of the direction and presence of associations rather than their exact magnitude. Third, exact warm and cold ischemia durations and preservation conditions could not be reliably reconstructed from the medical records. Fourth, the primary outcome was based on short-term replantation viability at one month, and functional outcomes were not systematically evaluated in this study. Standardized functional assessments, including range of motion, grip strength, sensory testing, and validated patient-reported outcome measures, were unavailable. Therefore, successful replantation in the present study should be interpreted as short-term survival of the replanted digit rather than evidence of functional recovery. Longer-term outcomes, including functional recovery and return to work, could not be evaluated; previous systematic evidence indicates that clinically meaningful recovery and return to occupational activity may extend well beyond the one-month assessment used in the present study [6,17]. Fifth, outcomes were analyzed at the patient level; therefore, in patients undergoing multiple-digit replantation, failure of a single replanted digit resulted in classification of the entire patient as a failure. This approach may have increased the probability of failure classification among patients with multiple replanted digits**.** Sixth, complications were obtained retrospectively from clinical records and could overlap, preventing causal attribution of individual complications to replantation failure. Finally, the exploratory MESS cutoff was derived from the present cohort without external validation.

Despite these limitations, the study has several strengths. It evaluates a clinically relevant cohort of patients undergoing digital replantation, incorporates patient-related, injury-related, and treatment-timing variables, and uses multivariable analysis rather than relying solely on unadjusted comparisons. The patient-level outcome definition provides a consistent analytical framework for patients undergoing single- or multiple-digit replantation. In addition, the separate ROC analysis provides an exploratory assessment of the potential prognostic information contained in MESS while avoiding its simultaneous inclusion with the overlapping injury-mechanism variable in the primary multivariable model.

Conclusion

Digital replantation was successful at one month in approximately three-quarters of patients in this cohort. Smoking, diabetes mellitus, hypertension, and injury mechanism were independently associated with replantation failure, whereas age, sex, and the hospital arrival-to-replantation interval were not independently associated with outcome. MESS demonstrated good discrimination for replantation failure; however, the identified cutoff should be considered exploratory and requires external validation. These findings support a multifactorial approach to outcome assessment after digital replantation, integrating patient characteristics and injury severity rather than relying on a single risk factor or scoring system.

Ethical Approval

This study was approved by the Başkent University Non-Interventional Clinical Research Ethics Committee (Project No: KA24/332; Decision No: 26/223; Date: 02.07.2026) and supported by the Başkent University Research Fund. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent

This retrospective study was based on anonymized existing clinical records and did not involve additional interventions or direct patient contact. No research-specific informed consent was obtained.

Conflict of Interest

The authors confirm the absence of any conflicts associated with this work.

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Presentation

Preliminary findings from this study were presented as an oral presentation at the 2nd International Trauma Congress, held in Konya, Türkiye, on November 27-30, 2025. A two-page conference report was published in the congress proceedings book (January 2026, pp. 43-44).

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