



Postoperative Complications of Minor Hand Surgical Procedures Performed in a Minor Operating Room: The Impact of Surgeon Level and Operative Time

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Purpose: This study aimed to assess postoperative complications after minor hand surgical procedures performed in a minor operating room and to identify factors associated with these complications.

Methods: This retrospective cohort study conducted at a tertiary university hospital in Bangkok, Thailand, included patients who underwent minor hand surgical procedures in minor operating rooms from January 2019 to October 2024. Data collected included demographic characteristics, operative time, surgeon level, and postoperative complications. Risk factors evaluated included age >60 years, comorbidities, operative time, and surgeon level. Univariate and multivariate logistic regression analyses were conducted.

Results: A total of 1,432 patients were included (mean age, 61.8 ± 13.3 years). The most common procedures were trigger finger release, carpal tunnel release, and soft tissue mass excision. Most procedures were performed by staff surgeons (72.5%), followed by residents (24.9%) and fellows (2.6%). The median operative time was 30 min. Twenty-eight postoperative complications occurred (1.96%), most commonly wound dehiscence, incomplete release, and surgical site infection; 13 cases required reoperation. Longer operative time (adjusted odds ratio, 1.025; 95% confidence interval, 1.001–1.050; $p = 0.043$) and surgeon level were independently associated with postoperative complications. Residents and fellows had higher odds of complications than staff surgeons, whereas diabetes mellitus and age >60 years were not significantly associated with complications.

Conclusions: Minor hand surgical procedures showed a low complication rate, supporting the safety of this setting. Although residents and fellows had higher complication rates, appropriate supervision and careful case selection remain essential components of orthopedic training.

Keywords: hand surgery, minor surgical procedures, minor operating room, postoperative complication, resident

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Minor surgical hand procedures are minimally invasive interventions performed under local anesthesia. These procedures offer several benefits, including improved patient satisfaction, lower complication rates, and greater cost efficiency⁽¹⁻⁴⁾. They are commonly used to treat frequent hand conditions such as carpal tunnel syndrome, trigger finger, radial styloid tenosynovitis, and soft tissue mass or cyst excision. With advances in surgical techniques and the increasing use of wide-awake

local anesthesia with no tourniquet (WALANT), the use of minor operating rooms has increased significantly^(1, 5).

Although minor hand surgeries are generally considered safe, postoperative complications may still occur and can influence both short- and long-term outcomes. These complications are affected by multiple factors, including surgical technique, intraoperative variables such as procedure type and duration, and patient-related characteristics such as age and comorbidities⁽⁶⁾. In particular, older age, underlying conditions such as diabetes mellitus, ischemic heart disease, and prolonged corticosteroid use, as well as longer operative time, have been associated with higher risks of postoperative complications⁽⁴⁾. Accordingly, careful perioperative management is essential.

In recent years, there has been a shift from standard operating rooms to minor operating rooms or procedure rooms for managing common hand conditions. This transition has been driven by advantages such as reduced costs through the avoidance of preoperative laboratory testing and operating room expenses, lower complication rates, and shorter surgical waiting times^(1, 5, 7, 8). Moreover, prior studies have shown that hand surgeries performed in procedure rooms are safe and effective, supporting their broader adoption in clinical practice^(1-3, 9, 10). In Thailand, particularly in rural regions, access to standard operating rooms may be limited, and patients may be unwilling or unable to travel to tertiary or provincial hospitals. As a result, minor operating rooms play a key role in improving access to surgical care for hand conditions.

Despite the increasing use of minor surgical settings for hand procedures, gaps remain in understanding real-world outcomes and the factors influencing postoperative complications, particularly across diverse healthcare systems. Most available studies have been conducted in Western populations, whereas data from Southeast Asia remain limited. Furthermore, the influence of patient characteristics, variations in minor operating room settings, and surgeon experience on outcomes has not been fully clarified. Therefore, this study aimed to evaluate postoperative compli-

cations after hand surgeries performed in a minor operating room at a tertiary university hospital in Bangkok, Thailand. Furthermore, we sought to assess the associations of patient demographics, comorbidities, operative time, and surgeon experience with postoperative complications.

METHODS

This retrospective cohort study included all patients with various hand conditions who underwent minor hand surgical procedures between January 1, 2019, and October 31, 2024, at a tertiary university hospital in Bangkok, Thailand. Data were obtained from the hospital electronic medical records and the Electronic Public Health Information System (ePHIS).

Patients were identified using International Classification of Diseases, 10th Revision (ICD-10) diagnostic codes for common hand conditions, including carpal tunnel syndrome (G56.0), trigger finger (M65.3), soft tissue masses of the upper extremity (R22.3 and R22.7), de Quervain tenosynovitis (M65.4), ganglion cysts (M67.4), contractures (M24.54), open wounds of the upper extremity (S41, S51, S56, and S61), retained foreign bodies (Z18), ulnar or radial nerve compression (G56.2 and G56.3), ingrown nails (L60.0), synovitis (M65.94), arthritis (M13.83 and M13.94), septic arthritis (M00.9), duplicated thumb (Q69.1 and Q69.9), and giant cell tumor of the tendon sheath (D48.1). Corresponding procedures were identified using ICD-9 procedure codes, including carpal tunnel release (04.33), trigger finger release (82.21), mass excision (82.29 and 83.39), first dorsal compartment release (82.01 and 82.21), Z-plasty (86.84), wound suturing (86.59), foreign body removal (82.29, 86.05, and 98.20), external neurolysis (04.49), nail extraction (86.23), synovectomy (80.73), mass biopsy (80.33 and 80.34), and repair of superficial radial nerve injury (04.76).

The study protocol was approved by the Institutional Ethics Committee (COA no. 165/67E). All patient identifiers were anonymized and replaced with sequential codes, and data access was restricted to the research team to maintain confidentiality.

Minor hand surgical procedures were performed in a minor operating room equipped with two operating tables (Figure 1). When two procedures were performed simultaneously, a folding screen was used to separate the operating areas. Patients were changed into hospital gowns and positioned supine with an adjustable hand table. A standardized sign-in procedure was used to confirm patient identity, diagnosis, procedure, and surgical site.



Fig. 1 Minor operating room at Vajira Hospital.

Local anesthesia using 1%–2% lidocaine, with or without epinephrine, was administered. A tourniquet was used in selected cases, and the WALANT technique was applied at the surgeon's discretion. Standard sterile techniques were followed in all cases. Procedures were performed by orthopedic staff surgeons, fellows in subspecialty training, or fourth-year orthopedic residents permitted to operate independently, as well as third-year orthopedic residents operating under direct supervision, in accordance with the Thai Board of Orthopaedic Surgery curriculum. The operating team comprised a scrub nurse (practical nurse) and a circulating nurse.

Demographic and clinical data, including age, sex, comorbidities, diagnosis, procedure type, operative time, operating surgeon, and intraopera-

tive and postoperative complications, were collected from hospital records and follow-up visits. Patients were followed up through the ePHIS for approximately 1 year after surgery to identify postoperative complications. Comorbidities were identified from ePHIS records. Diabetes mellitus was defined by ICD-10 diagnostic codes (E08–E13) or documented use of antihyperglycemic medications or insulin, whereas hypertension and ischemic heart disease were identified by their respective ICD-10 diagnostic codes. Complications were defined using standardized criteria. Surgical site infection was defined according to Centers for Disease Control and Prevention guidelines⁽¹¹⁾. Wound dehiscence was defined as partial or complete separation of previously approximated wound edges caused by impaired healing⁽¹²⁾. Complex regional pain syndrome was defined as a clinical syndrome characterized by pain, autonomic dysfunction, trophic changes, and functional impairment following hand surgery⁽¹³⁾. Nerve injuries were classified as neurapraxia, defined as transient nerve conduction block with spontaneous recovery during follow-up⁽¹⁴⁾, and nerve transection, defined as disruption of nerve continuity requiring surgical repair. Stiff finger was defined as reduced range of motion in one or more fingers following surgery⁽¹⁵⁾. Other complications included persistent triggering or catching after trigger finger release and persistent or worsening symptoms following carpal tunnel release.

Risk factors for complications were analyzed by stratifying patients according to age (≤ 60 and > 60 years), diabetes mellitus, ischemic heart disease, operative time, and surgeon experience (staff surgeons, fellows, or orthopedic residents).

Statistical analyses were conducted using SPSS version 28 (IBM Corp., Armonk, NY, USA). Continuous variables such as age and operative time were presented as mean $\pm$ standard deviation for normally distributed data or as median with interquartile range (IQR) for non-normally distributed data. Categorical variables were reported as frequencies and percentages. Group comparisons were performed using the chi-square test or Fisher's exact test for categorical variables, as appropriate. For continuous variables, the indepen-

dent *t*-test was used for normally distributed data, whereas the Mann–Whitney U test was used for non-normally distributed data. Variables were selected for inclusion in the multivariate logistic regression model based on clinical relevance to identify independent factors associated with postoperative complications. Results were reported as odd ratios (ORs) with 95% confidence intervals (CIs). A *p* value <0.05 was considered statistically significant.

RESULTS

A total of 1,432 patients were included over the 5-year study period. Most patients were female (76%), with a mean age of 61.8 ± 13.3 years (Table 1). The most common diagnosis was trigger finger, followed by carpal tunnel syndrome, soft tissue masses or ganglion cysts, and de Quervain tenosynovitis. Other diagnoses included open wounds, retained foreign bodies, ulnar or radial

Table 1 Demographic and clinical characteristics of patients undergoing minor hand surgical procedures (n = 1432).

Age (years)	61.8 ± 13.3
≤60 years	623 (43.5)
>60 years	809 (56.5)
Sex	
Male	343 (24.0)
Female	1089 (76.0)
Comorbidities	
Diabetes mellitus	245 (17.1)
Hypertension	526 (36.7)
Ischemic heart disease	57 (4.0)
Diagnosis	
Trigger finger	584 (40.8)
Carpal tunnel syndrome	478 (33.4)
De Quervain tenosynovitis	112 (7.8)
Soft tissue mass/ganglion cyst	204 (14.2)
Trigger finger with carpal tunnel syndrome ^a	15 (1.1)
Trigger finger with de Quervain tenosynovitis ^a	8 (0.6)
Trigger finger with soft tissue mass ^a	6 (0.4)
Carpal tunnel syndrome with soft tissue mass ^a	2 (0.1)
De Quervain tenosynovitis with soft tissue mass ^a	3 (0.2)
Other diagnoses	20 (1.4)
Surgeon level	
Staff surgeon	1038 (72.5)
Fellow	37 (2.6)
Resident	357 (24.9)
Operative time (minutes)	30 [25–40]
Staff surgeon	30 [25–40]
Fellow	35 [27.5–40]
Resident	35 [30–42.5]
Single procedure	30 [25–40]
Two procedures	40 [34–51]

Values are presented as mean ± standard deviation, n (%), or median [interquartile range].

^aCombined diagnoses represent patients who underwent two surgical procedures during the same operative session.

nerve compression, ingrown nails, congenital hand conditions, and combined conditions such as carpal tunnel syndrome with trigger finger, carpal tunnel syndrome with dorsal wrist ganglion, and de Quervain tenosynovitis with trigger finger.

Most procedures were performed by staff surgeons (72.5%), whereas orthopedic residents and fellows accounted for 24.9% and 2.6% of cases, respectively. The median operative time was 30 min (IQR, 25–40). Slightly longer operative times were noted among fellows and residents (median, 35 min) than among staff surgeons (median, 30 min). Among 1,432 patients, 34 (2.4%) underwent two surgical procedures during the same operative session. The median operative time was significantly longer among patients undergoing two surgical procedures than among those undergoing a single procedure (40 [IQR, 34–51] vs. 30 [IQR, 25–40] min; $p < 0.001$). No procedures were discontinued because of patient intolerance or inability to complete the procedure, and no intraoperative complications were recorded.

A total of 28 postoperative complications were observed. The most common complications were wound dehiscence ($n = 7$), incomplete release following carpal tunnel or trigger finger surgery ($n = 6$), and surgical site infection ($n = 5$). The complication rate was highest among fellows (5.4%), followed by residents (4.2%) and staff surgeons (1.1%). The distribution of complication types according to surgeon level is shown in Figure 2. The distribution of postoperative complications according to surgical procedure is presented in Table 2. Thirteen patients required reoperation, including resuturing for wound dehiscence ($n = 5$), completion of trigger finger release for incomplete release ($n = 5$), completion of carpal tunnel release for incomplete release ($n = 1$), and digital nerve repair for nerve transection ($n = 2$). One patient with a surgical site infection following trigger finger release required hospital admission for intravenous antibiotic treatment.

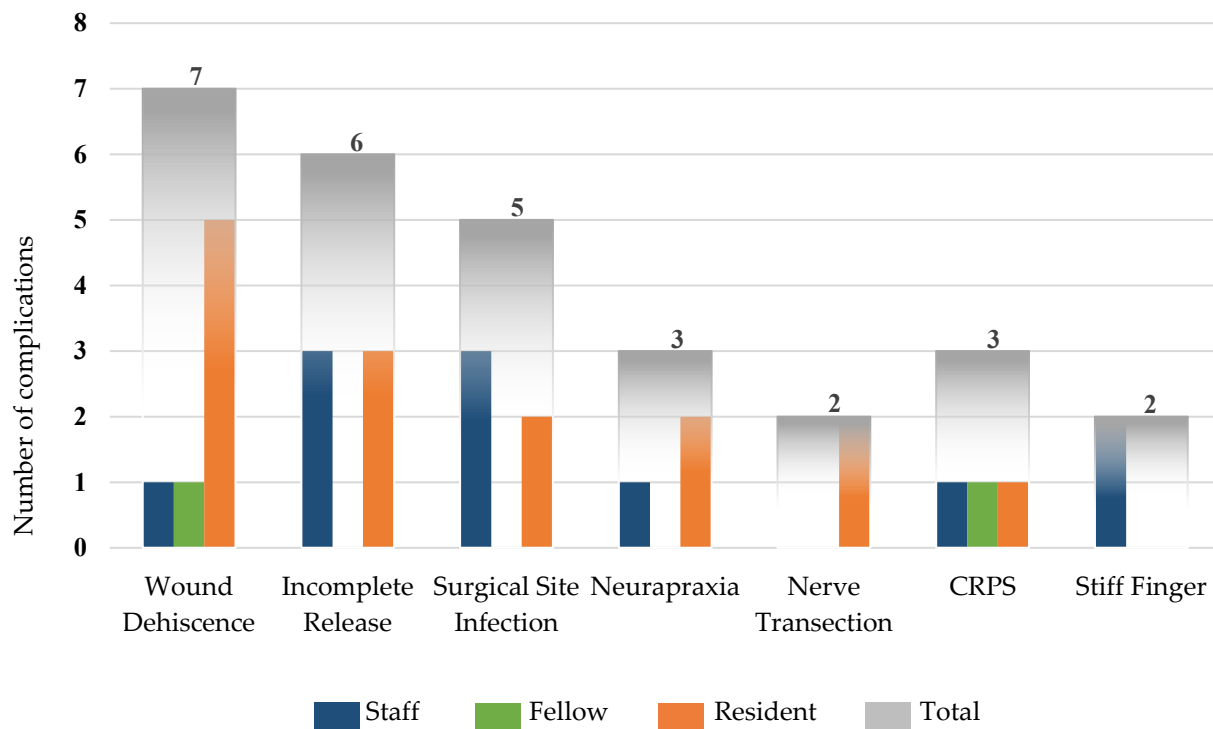


Fig. 2 Distribution of postoperative complications according to surgeon level, including staff surgeons, fellows, residents, and total cases. CRPS, complex regional pain syndrome.

Table 2 Distribution of postoperative complications by surgical procedure.

Postoperative complication	Trigger finger release	Carpal tunnel release	First dorsal compartment release	Mass excision	Carpal tunnel release with trigger release	Total (n)
Wound dehiscence	6	1	0	0	0	7
Incomplete release	5	1	0	0	0	6
Surgical site infection	3	0	0	2	0	5
Neurapraxia	2	0	1	0	0	3
Nerve transection	1	0	0	0	1	2
CRPS	0	2	0	0	1	3
Stiff finger	2	0	0	0	0	2
Total	19	4	1	2	2	28

Values are presented as number of cases (n).

CRPS, complex regional pain syndrome.

Table 3 Univariate analysis of factor associated with postoperative complications.

Variable	No complication (n = 1404)	With complication (n = 28)	p Value	Most frequent complication(s) ^a
Age group			0.401	Wound dehiscence, 3 (30)
≤60 years	613 (98.4)	10 (1.6)		Wound dehiscence, 4 (22.2)
>60 years	791 (97.8)	18 (2.2)		Incomplete release, 4 (22.2)
Sex			0.445	Incomplete release, 5 (21.7)
Female	1066 (97.9)	23 (2.1)		Wound dehiscence, 5 (21.7)
Male	338 (98.5)	5 (1.5)		Wound dehiscence, 2 (40)
Diabetes mellitus			0.364	Wound dehiscence, 7 (28)
No	1162 (97.9)	25 (2.1)		CRPS, 1 (33.3)
Yes	242 (98.8)	3 (1.2)		Neurapraxia, 1 (33.3)
Ischemic heart disease			0.911	Incomplete release, 1 (33.3)
No	1348 (98)	27 (2)		Wound dehiscence, 7 (25.9)
Yes	56 (98.2)	1 (1.8)		Neurapraxia, 1 (100)
Operative time (minutes)	30 [25–40]	37.5 [26.25–50]	0.136	–
Surgeon level			<0.001*	Incomplete release, 4 (36.4)
Staff surgeon	1027 (98.9)	11 (1.1)		Wound dehiscence, 1 (50)
Fellow	35 (94.6)	2 (5.4)		CRPS, 1 (50)
Resident	342 (95.8)	15 (4.2)		Wound dehiscence, 5 (33.3)

Values are presented as n (%) or median [interquartile range].

^aThe percentages in this column represent the proportion of the specific complication(s) among postoperative complications within the corresponding subgroup.

*Significant difference, $p < 0.05$.

CRPS, complex regional pain syndrome.

Factors associated with postoperative complications are summarized in Table 3. No significant differences in complication rates were observed by age group ($p = 0.401$) or diabetes mellitus status ($p = 0.364$). Operative time was longer in patients with complications than in those without complications; however, this difference was not statistically significant (median, 37.5 vs. 30 min; $p = 0.136$). Conversely, surgeon level was significantly associated with postoperative complications, with higher complication rates among procedures performed by fellows and residents than staff surgeons ($p < 0.001$).

Multivariate logistic regression results are presented in Table 4. Operative time was an independent factor associated with postoperative complications (adjusted OR, 1.025; 95% CI, 1.001–1.050; $p = 0.043$). Surgeon level also remained significantly associated with complications, with increased odds among procedures performed by residents (adjusted OR, 4.029; 95% CI, 1.826–8.890; $p = 0.001$) and fellows (adjusted OR, 5.595; 95% CI, 1.180–26.524; $p = 0.030$) compared with staff surgeons. Age and diabetes mellitus were not significantly associated with postoperative complications.

Table 4 Multivariable logistic regression analysis of independent factors associated with postoperative complications.

Variable	Adjusted OR	95% CI	<i>p</i> Value
Age >60 years (reference: ≤60 years)	0.656	0.294–1.466	0.304
Diabetes mellitus	1.967	0.582–6.646	0.276
Operative time (per minute)	1.025	1.001–1.050	0.043*
Surgeon level (reference: staff surgeon)			0.001*
Resident	4.029	1.826–8.890	0.001*
Fellow	5.595	1.180–26.524	0.030*

OR, odds ratio; CI, confidence interval.

*Significant difference, $p < 0.05$.

DISCUSSION

This retrospective cohort study showed a low overall complication rate (1.96%) following minor hand surgeries performed in a minor operating room. The three most frequently performed procedures were trigger finger release, carpal tunnel release, and soft tissue mass excision. Most procedures were performed by staff surgeons. Multivariate logistic regression analysis identified longer operative time and surgeon level as independent factors associated with postoperative complications.

The complication rate observed in the present study was low and comparable with rates reported previously. O'Brien et al. reported an overall complication rate of 8.9% among 202 hand surgical procedures performed in procedure rooms⁽²⁾. Knopp and Esmaeili⁽⁹⁾ and Carter et al.⁽¹⁶⁾ reported complication rates of 7.6% and 2.8%, respectively, among patients undergoing hand

surgery using the WALANT technique. Variability in complication rates across studies may be explained by differences in reporting methods, follow-up duration, and the types of procedures included. Collectively, these findings support the safety of performing minor hand surgical procedures in a minor operating room under local anesthesia.

Operative time was longer among patients who developed complications; however, the difference was not statistically significant in the univariate analysis. After adjustment for potential confounders, operative time remained a significant predictor in the multivariate model (adjusted OR, 1.03 per minute; 95% CI, 1.001–1.050; $p = 0.043$), indicating that each additional operative minute increased the likelihood of postoperative complications by approximately 3%. In a large analysis of 10,646 hand surgical procedures, Lipira et al. reported that longer operative time was associated

with increased postoperative complications in univariate analysis, but the association was not maintained after multivariate adjustment⁽⁴⁾. Systematic reviews by Cheng et al. examining the relationship between operative time and complications concluded that prolonged operative duration increases the risk of postoperative complications and surgical site infection^(17, 18). In contrast, Lin et al. found no increase in complications despite longer operative times during elective hand surgery performed during the COVID-19 pandemic⁽¹⁹⁾. Prolonged operative time may reflect greater procedural complexity and may increase the risk of wound-related complications because of extended microbial exposure and greater soft tissue manipulation⁽¹⁸⁾. In the present study, operative time may have been influenced by procedure complexity and multiple procedures performed during the same operative session. These cases were retained in the analysis because they represent routine clinical practice in the minor operating room; therefore, the association between operative time and postoperative complications should be interpreted cautiously.

Surgeon level was also independently associated with postoperative complications. Procedures performed by residents and fellows were associated with higher odds of complications than those performed by staff surgeons. Among resident-performed procedures, wound dehiscence was the most common complication, consistent with findings by Prompattanakdee et al., who reported wound dehiscence and surgical site infection as the most common postoperative complications following minor procedures performed by residents⁽²⁰⁾. Wound dehiscence may be influenced by wound type, location, underlying disease, closure materials, surgical techniques, smoking history, age >65 years, and wound infection⁽²⁰⁾. Although there was no difference in suture material among surgeon levels in our study, differences in soft-tissue handling or suture technique may have contributed to the observed difference. Samade et al. reported that complication rates decreased during the first 5 years of independent hand surgery practice, suggesting that accumulating surgical experience reduces postoperative compli-

cations over time⁽²¹⁾. The timing of suture removal may also have differed because resident-performed case were generally followed by the resident; however, the exact timing of suture removal was not consistently documented. Diabetes mellitus was not significantly associated with postoperative complications in our study.

Minor hand surgical procedures are a core component of the Thai orthopedic residency training. Residents progressively develop operative skills by assisting during procedures in the first and second years of training, participating in the Basic Surgical Exposures in Orthopaedic Cadaveric Workshop organized by the Royal College of Orthopaedic Surgeons of Thailand at the beginning of the third year, and subsequently performing procedures as the primary surgeon under the direct staff supervision with immediate feedback throughout training. Participation in these procedures enhances surgical technique, soft tissue handling, and operative independence, all of which are essential for more complex orthopedic procedures^(20, 22). Several studies in hand surgery have demonstrated that resident involvement is associated with longer operative times, consistent with the findings of the present study⁽²³⁻²⁵⁾. This may reflect the additional time required for intraoperative teaching and differences in technical proficiency and experience across surgeon levels⁽²⁵⁾. Nevertheless, most increases in operative time associated with resident and fellow participation represent an expected and necessary component of surgical education and essential for training competent orthopedic surgeons.

Diabetes mellitus and age >60 years were not significantly associated with postoperative complications in the present study. Previous studies have identified both variables as potential risk factors for complications following common hand surgeries⁽²⁶⁻²⁹⁾. In particular, diabetes mellitus has been linked to increased risks of wound-healing complications and surgical site infection^(28, 29). However, glycemic control, reflected by elevated hemoglobin A1c (HbA1c) levels >7% and higher preoperative blood glucose levels, may be a stronger predictor of postoperative complications than the diagnosis of diabetes mellitus alone^(4, 26-28).

This represents an important limitation of the present study because preoperative HbA1c and blood glucose data were unavailable for analysis. Older age has also been linked to increased postoperative risk of complications because of delayed wound healing, greater susceptibility to surgical site infection, higher likelihood of joint stiffness, and a greater burden of comorbidities⁽²⁶⁾. However, the absence of significant associations in this cohort suggests that, with appropriate patient selection and perioperative management, minor hand surgical procedures can be safely performed in older adults and in patients with diabetes mellitus who maintain adequate preoperative glycemic control.

This study has several strengths. To the best of our knowledge, it is the first to evaluate surgeon-level factors (residents, fellows, and staff surgeons) in minor hand surgical procedures performed in a minor operating room. Additional strengths include the large sample size and inclusion of a broad range of common hand surgical procedures representative of routine practice in a real-world teaching hospital setting. However, several limitations should be considered. First, the retrospective design may have introduced incomplete or inaccurate documentation, potentially resulting in underreporting of postoperative complications. Second, the low overall complication rate may have reduced statistical power to detect associations with less common risk factors. Third, preoperative HbA1c and blood glucose levels were unavailable, preventing evaluation of the impact of glycemic control on postoperative outcomes. Similarly, the history and timing of preoperative corticosteroid injections were not consistently documented, particularly when injections were performed at other hospitals, and therefore could not be evaluated as potential risk factors for postoperative wound complications. Future studies should incorporate these variables to better clarify their relationship to better clarify this relationship. Fourth, multiple procedures performed during the same operative session may have influenced the association between operative time and postoperative complications. Fifth, the relatively small number of procedures performed by

fellows may have limited the precision of subgroup estimates. Finally, this study focused primarily on postoperative complications and did not evaluate functional outcomes or patient satisfaction, both of which are important indicators of success in hand surgery. Future studies should incorporate both clinical and patient-reported outcome measures to provide a more comprehensive assessment of surgical effectiveness.

CONCLUSION

Minor hand surgical procedures performed in a minor operating room under local anesthesia were associated with a low overall postoperative complication rate (1.96%), supporting the safety of this setting for common hand procedures. Longer operative time and surgeon level were independently associated with postoperative complications, whereas diabetes mellitus and age >60 years were not significant predictors.

Although procedures performed by residents and fellows were associated with modestly longer operative times and higher complication rates than those performed by staff surgeons, their participation under appropriate staff supervision and careful case selection remains an essential component of orthopedic training. These findings support both the clinical safety and educational value of performing minor hand surgical procedures in a teaching hospital setting.

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