

# Prevalence and Risk Factors for Postoperative Complications Following Open A1 Pulley Release for a Trigger Finger or Thumb

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**Purpose** Although A1 pulley release is an effective treatment to reduce pain and improve hand function, complications may occur. More insight into risk factors for complications is essential to improve patient counseling and potentially target modifiable risk factors. This study aimed to identify factors associated with complications following A1 pulley release.

**Methods** Patients completed baseline questionnaires, including patient characteristics, clinical characteristics, and the Michigan Hand outcomes Questionnaire. We retrospectively reviewed medical records to identify complications classified using the International Consortium for Health Outcome Measurement Complications in Hand and Wrist conditions tool. Grade 1 complications comprise treatment with additional hand therapy, splinting, or analgesics, grade 2 treatment with antibiotics or steroid injections, grade 3A minor surgical treatment, grade 3B major surgical treatment, and grade 3C complex regional pain syndrome. Logistic regression analyses were performed to examine the contribution of patient characteristics, clinical characteristics, and patient-reported outcome measurement scores to complications.

**Results** Of the included 3,428 patients, 16% incurred a complication. The majority comprised milder grades 1 (6%) and 2 (7%) complications, followed by more severe grades 3B (2%), 3C (0.1%), and 3A (0.1%) complications. A longer symptom duration (standardized odds ratio [SOR], 1.09),  $\geq 3$  preoperative steroid injections (SOR, 3.22), a steroid injection within 3 months before surgery (SOR, 2.02), and treatment of the dominant hand (SOR, 1.34), index finger (SOR, 1.65), and middle finger (SOR, 2.01) were associated with a higher complication rate.

**Conclusion** This study demonstrates that  $\geq 3$  preoperative steroid injections and a steroid injection within 3 months before surgery were the most influential factors contributing to complications. These findings can assist clinicians during patient counseling and may guide preoperative treatment. We recommend that clinicians should consider avoiding steroid

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injections within 3 months before surgery and to be reluctant to perform >2 steroid injections. (*J Hand Surg Am.* 2022;47(9):823–833. Copyright © 2022 by the American Society for Surgery of the Hand. All rights reserved.)

**Type of study/level of evidence** Prognostic II.

**Key words** Postoperative complications, trigger finger, trigger finger release.



**T**RIGGER FINGER IS A COMMON musculoskeletal condition, with a lifetime risk of 3% in the general population.<sup>1</sup> Corticosteroid injections are the mainstay of treatment, resulting in resolution of symptoms in 40%–90% of patients.<sup>2–4</sup> In cases of failed nonsurgical treatment or severe symptoms (e.g., a flexion contracture), a surgical A1 pulley release can be considered.<sup>5</sup> Although it is well-known that A1 pulley release can considerably reduce pain and improve hand function,<sup>6,7</sup> complications such as infection and nerve injury may occur.<sup>8</sup> Postoperative complications are associated with a prolonged recovery time, delayed resumption of work, and costs associated with additional interventions.<sup>9</sup>

Within the literature, the reported complication rates vary widely from 0% to 43%.<sup>10,11</sup> This is mainly due to inconsistent definitions of complications, as some studies only consider objective events (e.g., infection, nerve injury) as a complication, whereas other studies also include patient-reported complications (e.g., stiffness or pain).<sup>12</sup> In a previous study, we used the recently recommended International Consortium for Health Outcome Measurement Complications in Hand and Wrist conditions (ICHAW) tool<sup>13,14</sup> to classify complications in a large sample of patients who underwent A1 pulley release.<sup>6</sup> We found that 17% of all patients had a complication. Despite that most complications were mild, 2% of all patients required reoperation. Although these findings contribute to a deeper knowledge of the incidence and severity of postoperative complications, insight into risk factors for these complications is needed to increase the clinical use of these results.

Previous studies identified several risk factors for postoperative complications, including male sex,<sup>15,16</sup> smoking,<sup>9</sup> and diabetes.<sup>9,12</sup> While most studies primarily considered patient characteristics, only a few evaluated clinical characteristics. For example, the number of preoperative steroid injections and the time between the last injection and surgery have been studied mainly in relation to postoperative infections.<sup>16–19</sup> Considering that these factors may

be accounted for during preoperative management, more insight into these risk factors is essential to improve patient counseling and potentially target modifiable risk factors. Therefore, this study aimed to identify patient characteristics, clinical characteristics, and preoperative patient-reported outcome measurement scores associated with complications following surgical A1 pulley release. In addition, we evaluated if these risk factors differ based on the severity of the complication.

## METHODS

### Study design and setting

This cohort study of patients who underwent open A1 pulley release is based on data from the Hand and Wrist Study Cohort,<sup>20</sup> reported following the Strengthening the Reporting of Observational Studies in Epidemiology guideline.<sup>21</sup> Between January 2013 and May 2020, data were collected as part of routine outcome measurements at Xpert Clinics Hand and Wrist Care, comprising 25 different locations for hand surgery and hand therapy in the Netherlands, 23 European Board-certified hand surgeons, and more than 150 hand therapists. The cohort, data collection<sup>20</sup> and their use in daily clinical care<sup>22</sup> were described previously in more detail. The local institutional review board approved the study. All patients provided written informed consent to be included in our database. Ethical approval of this study was obtained from the medical ethics review committee of the Erasmus Medical Centre.

### Participants

All patients who underwent open release of a trigger finger or trigger thumb were screened for eligibility. Patients were excluded if they were <18 years old, they had undergone a prior A1 pulley release of the same finger, they had undergone surgical treatment of the ipsilateral or contralateral hand within 3 months before the A1 pulley release, they were treated for multiple trigger fingers; they underwent an additional procedure during the same session (e.g., excision of

the flexor digitorum superficialis slip, carpal tunnel release), there were missing data in baseline questionnaires, there were missing data in the number of preoperative steroid injections or the time between the last steroid injection and surgery, or we were unable to identify complications owing to the absence of follow-up documentation in the medical records.

### Treatment

All surgeries were performed by Federation of European Societies for Surgery of the Hand-certified hand surgeons, with experience levels varying from 2–5.<sup>23</sup> Surgeries were performed in the operating room and the majority of patients received local anesthesia. Incisions were made according to surgeon preference, followed by release of the A1 pulley. The wounds were closed using nonabsorbable sutures, which were removed between 10 and 14 days after surgery.<sup>24</sup> All patients were offered standardized postoperative care, including a bandage for 3 to 5 days and 3 sessions of supervised hand therapy comprising tendon gliding exercises. Each patient received a follow-up appointment with their hand surgeon 3 months after surgery to evaluate the treatment outcome. When indicated, additional sessions with the hand surgeon or hand therapist were scheduled (e.g., in the case of an infection or slow recovery of motion).

### Variables and measurements

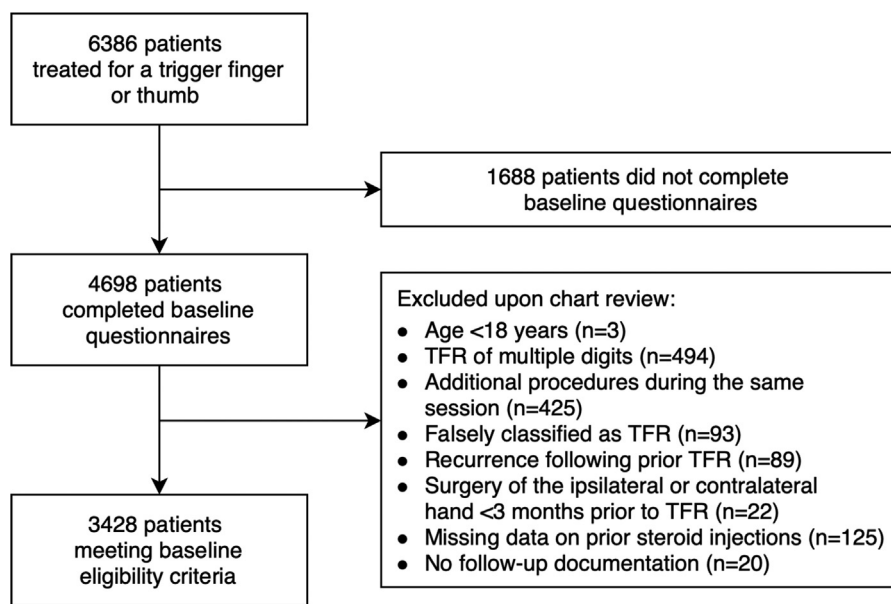
Two researchers (i.e., one medical doctor and one medical student) not involved in patient care retrospectively reviewed all medical records to identify postoperative complications. Complications were classified according to the ICHAW tool,<sup>13,14</sup> where a complication is defined as any deviation from the normal treatment course and the grade of the complication is based primarily on the invasiveness of the employed intervention (Table 1). Grade 1 comprises treatment with additional hand therapy, splinting, or analgesics; grade 2, treatment with antibiotics or steroid injections; grade 3A, minor surgical treatment (e.g., removal of a retained suture); grade 3B, major surgical treatment; and grade 3C, complex regional pain syndrome. In line with the ICHAW classification, we did not include events as complications if they are considered part of the normal treatment course. For example, we did not consider a limited range of motion as a complication if patients presented with a preoperative flexion contracture or if it was reported that their range of motion had improved compared to baseline. When a

**TABLE 1. Definition of Complications Following the International Consortium for Health Outcome Measurement Complications in Hand and Wrist Conditions Tool (ICHAW) classification**

Grade	Definition
Grade 1	Any deviation from the normal treatment course without the need for surgical or radiologic interventions. Acceptable therapeutic regimens are: extra analgesics, additional hand therapy, splinting, or a cast. This grade includes: tendinitis, scar tenderness, temporary sensory disturbances, etc.
Grade 2	Any deviation from the normal treatment course requiring antibiotics, steroid injections, or other pharmacologic treatment not listed in grade 1. This also includes wound infections and hematomas not needing anesthesia.
Grade 3	Any deviation from the normal treatment course requiring surgical, endoscopic, or radiologic intervention. Additionally, this includes tendinitis, scar tenderness, persistent pain, etc. not responding to conservative therapy, drugs, or injections.
A	Minor surgical intervention under local anesthesia (e.g., removal of a retained suture).
B	Major surgical intervention under regional or general anesthesia (e.g., repeat surgery, tenolysis, neurolysis, nerve repair).
C	Complex regional pain syndrome, diagnosed using Budapest criteria, independent of the initiated treatment.

complication was suspected, this was checked by a second researcher, and discussed with the senior investigator if necessary. In case of multiple complications within the same patient, only the most severe complication was documented. This was based primarily on the complication grades. For example, if a patient with a complex regional pain syndrome (grade 3C) also had a limited range of motion treated with hand therapy (grade 1), this patient was assigned only the more severe grade 3C complication. However, if a patient had multiple complications within the same grade (e.g., a limited range of motion due to a scar contracture), we documented only the initial complication that also contributed to the second complication (i.e., in this case, a scar contracture).

Baseline characteristics were classified into 3 categories: patient characteristics, clinical characteristics, and preoperative patient-reported outcome measures. Patient characteristics were collected routinely at baseline and included age, sex, body mass index, current smoking, the presence of systemic comorbidity (i.e.,



**FIGURE 1:** Flowchart of the study. TFR, trigger finger release.

diabetes, rheumatic autoimmune disease, and hypothyroidism), and type of work. Clinical characteristics routinely collected at baseline included the treatment side, the affected digit, and symptom duration. In addition, documentation about the presence of a flexion contracture before surgery, the number of preoperative steroid injections, and the time between the last injection and surgery were retrieved retrospectively from the medical records. Preoperative patient-reported outcome measures included the Michigan Hand outcomes Questionnaire.<sup>25</sup> Since we were interested mostly in self-reported pain intensity and hand function, we only used the “pain” and “overall hand function” subdomains of the Michigan Hand outcomes Questionnaire. The scores on both subdomains range from 0–100. We reversed the pain subscale in this study for interpretability, so that higher scores indicate better performance on both subdomains.

### Statistical methods

We performed a multivariable logistic regression analysis to investigate the independent contribution of patient characteristics, clinical characteristics, and patient-reported outcome measurement scores to the occurrence of complications following A1 pulley release. Using the convention of 10 events per variable, our sample including 530 patients with a complication was adequate to fit a multivariable logistic regression analysis with 23 independent variables.<sup>26,27</sup> As a subanalysis, we performed multivariable logistic regression analyses for the complication grades separately. Results are reported

as unstandardized odds ratios and the corresponding 95% confidence interval. We also reported the SOR to compare the relative contribution of each explanatory variable. The model assumptions were checked using scatter plots, residuals, and variance inflation factors. All variables yielded a variance inflation factor <2, implying that there was no indication of multicollinearity.<sup>28</sup>

### RESULTS

A total of 3,428 patients were included in this study (Fig. 1). The baseline characteristics of the included patients are listed in Table 2, indicating that the thumb (33%) and middle finger (30%) were most frequently affected. The median symptom duration was 6 months and 62% of patients received  $\geq 1$  preoperative steroid injections. Complications occurred in 530 (16%) of the 3,428 patients (Table 3). The majority of the complications consisted of grades 1 (6% of all patients) and 2 (7%) complications, followed by the more severe grades 3B (2%), 3C (0.1%), and 3A (0.1%) complications.

### Prognostic factors for complications

Table 4 shows the results from the logistic regression analysis. We found that treatment of the dominant hand (SOR, 1.34), a longer symptom duration (SOR, 1.09),  $\geq 3$  preoperative steroid injections (SOR, 3.22), and a steroid injection within 3 months before surgery (SOR, 2.02) were associated with a higher occurrence of complications.

**TABLE 2. Baseline Characteristics of the Study Sample ( $n = 3,428$ )**

Variable	Value
<b>Patient characteristics</b>	
Age (y), mean $\pm$ SD	59 $\pm$ 11
Female sex, %	67%
Body mass index, mean $\pm$ SD	27 $\pm$ 6
Current smoking, %	14%
Systemic comorbidity, %	
Diabetes	12%
Rheumatic autoimmune disease	12%
Hypothyroidism	6%
Type of work, %	
Not employed (e.g., unemployed or retired)	43%
Light physical labor (e.g., working in an office)	25%
Moderate physical labor (e.g., working in a shop)	22%
Heavy physical labor (e.g., construction work)	10%
<b>Clinical characteristics</b>	
Dominant hand affected, %	57%
Affected digit, %	
Thumb	33%
Index finger	8%
Middle finger	30%
Ring finger	24%
Little finger	5%
Duration of symptoms (mo), median (IQR)	6 (4–12)
Flexion contracture of the affected digit, %	13%
Number of preoperative steroid injections, %	
0 injections	38%
1 injection	43%
2 injections	16%
$\geq 3$ injections	3%
Steroid injection <3 mo before surgery, %	7%
Patient-reported outcome measures (range 0–100)	
MHQ pain, mean $\pm$ SD	50 $\pm$ 20
MHQ hand function, mean $\pm$ SD	61 $\pm$ 19

IQR, interquartile range; MHQ, Michigan hand outcome questionnaire.

Additionally, treatment of the index finger (SOR, 1.65) and middle finger (SOR, 2.01) was associated with a higher incidence of complications than that of the thumb. An overview of all variables that were significantly associated with complications (i.e.,  $P$ -value below .05) is provided in [Figure 2](#), indicating that  $\geq 3$  preoperative steroid injections and a steroid

injection within 3 months before surgery were the most influential factors contributing to postoperative complications.

### Prognostic factors for the separate complication grades

[Table 5](#) provides an overview of the logistic regression models for the different complication grades. We found that a longer symptom duration was associated only with grade 1 complications. In contrast, a preoperative flexion contracture and a steroid injection within 3 months before surgery were associated with grades 2 and 3 complications, but not with grade 1 complications. Prior treatment with  $\geq 3$  preoperative steroid injections contributed to all complication grades, whereas any number of preoperative steroid injections was associated only with grade 2 complications. For grades 1 and 2 complications, the most influential factor was  $\geq 3$  preoperative steroid injections (SOR, 3.37 and SOR, 3.20, respectively; [Fig. 2](#)). For grade 3 complications, a steroid injection within 3 months before surgery was the most influential factor (SOR, 3.15).

## DISCUSSION

Postoperative complications are associated with a prolonged recovery time, delayed resumption of work, and costs associated with additional interventions.<sup>9</sup> Therefore, this study aimed to identify factors associated with complications following A1 pulley release. Complications occurred in 16% of all patients and although most complications were mild, 2% of all patients required reoperation. We found that  $\geq 3$  preoperative steroid injections and a steroid injection within 3 months before surgery were the most influential factors contributing to complications, indicating that clinicians should consider avoiding steroid injections within 3 months before surgical A1 pulley release and to be reluctant in performing  $>2$  steroid injections.

The complication rate of 16% we found is in the middle of the wide range described in literature (0%–43%).<sup>10,11</sup> This wide range is mainly due to inconsistencies in the definition of complications and the absence of a widely accepted classification system. In this study, we used a recently recommended ICHAW classification tool, where a complication is defined as any deviation from the normal treatment course.<sup>13,14</sup> An advantage of this classification tool is that it provides insight into the severity of the complications based on the invasiveness of the intervention used. For example, although we found a high complication rate of 16%, it is important to acknowledge that 40% of all complications consisted of grade 1 complications (i.e.,

**TABLE 3. Distribution of Complications According to the International Consortium for Health Outcome Measurement Complications in Hand and Wrist Conditions Tool (ICHAW) Classification**

Complications, % of Total Sample	ICHAW Classification					Total (15.5%)
	Grade 1 (6.2%)	Grade 2 (7.2%)	Grade 3A (0.1%)	Grade 3B (1.8%)	Grade 3C (0.1%)	
Limited range of motion*	3.2%	0.2%	—	0.6%	—	3.9%
Persistent swelling and/or pain	0.9%	2.9%	—	—	—	3.8%
Infection	—	2.7%	—	0.5%	—	3.2%
Scar issues†	1.6%	0.7%	—	—	—	2.3%
Persistence or recurrence	0.3%	0.8%	—	0.6%	—	1.6%
Wound issues‡	0.1%	—	0.1%	0.1%	—	0.3%
Neurapraxia	0.2%	—	—	0.1%	—	0.3%
CRPS	—	—	—	—	0.1%	0.1%
Bowstringing	0.03%	—	—	0.03%	—	0.1%

Results are presented as percentages of the total sample. This table shows that complications occurred in 16% of the patients, of which a limited range of motion, persistent swelling or pain, and infection occurred most frequently. CRPS, complex regional pain syndrome.

\*Limited range of motion due to adhesions or persistent stiffness (i.e., not including a limited range of motion caused by persistent swelling, scar issues, or bowstringing).

†Scar issues, including keloid, hypertrophic, hypersensitive, and scar contracture.

‡Wound issues, including dehiscence and retained suture.

treatment with additional hand therapy, splinting, or analgesics), of which most can be considered as delayed recovery. However, despite that most complications were mild, 2% of all patients experienced a complication requiring reoperation.

We found that  $\geq 3$  preoperative steroid injections was the most influential factor for postoperative complications. A plausible explanation for these findings may be that patients requiring multiple steroid injections represent a group with a more advanced condition that is more difficult to treat. However, as we found that multiple steroid injections were independently associated with complications after correcting for the symptom duration, the presence of a preoperative flexion contracture, baseline pain, and hand function scores, this suggests that a higher number of steroid injections also may have a negative impact on postoperative outcomes. Furthermore, although steroid injections have been proven to be effective in the initial management of a trigger finger,<sup>29</sup> it has been found that the success rate decreases following multiple injections.<sup>2,30</sup> For instance, one study reported resolution of symptoms in 49% of patients following a single steroid injection, whereas this was achieved in only 23% of patients after the second injection, and in 5% after  $\geq 3$  steroid injections.<sup>30</sup> Considering the increase in complication rate and decrease in efficacy following  $\geq 3$  steroid injections, these findings imply

that hand surgeons should be reluctant to perform  $> 2$  steroid injections.

In line with this, we also observed that a steroid injection within 3 months before surgery was associated with postoperative complications. Interestingly, this association was observed only for the more severe grades 2 and 3 complications. These results are consistent with previous studies reporting that a shorter duration between a steroid injection and surgery was associated with postoperative infections.<sup>16,17,19</sup> However, it should be noted that Straszewski et al<sup>16</sup> only observed a higher prevalence of deep infections if the steroid injection was performed within 1 month before surgery. These findings indicate that clinicians should at least avoid surgery within 1 month following a steroid injection, and probably even 3 months.

An interesting finding of this study is that we found differences in the complication rates between the separate digits, with the highest incidence in the index and middle fingers. This is in line with the findings of Bruijnzeel et al<sup>12</sup> who also found that treatment of the middle finger was associated with the occurrence of complications. A possible explanation for this finding is the difference in functional anatomy. For example, because the index and middle fingers have an important role in fine motor skills, it is plausible that patients experience more difficulties

**TABLE 4. Multivariable Logistic Regression Analysis for Complications**

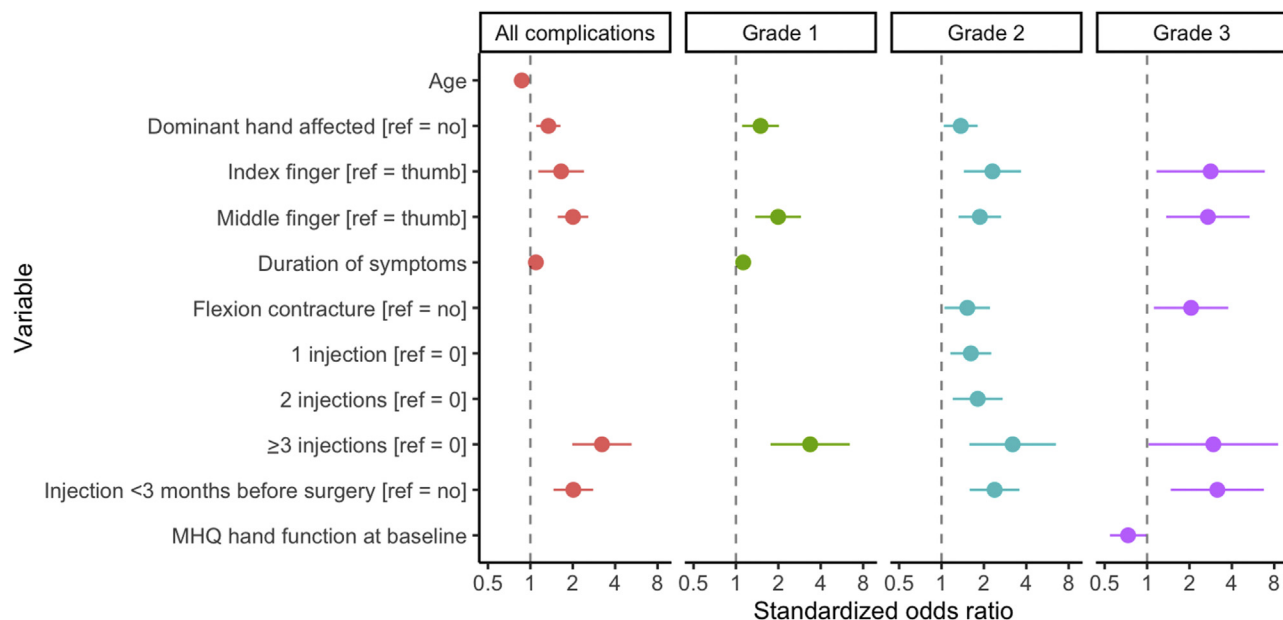
	Univariable		Multivariable	
	OR (95% CI)	SOR	OR (95% CI)	SOR
<b>Patient characteristics</b>				
Age (y)	<b>0.99 (0.98; 0.99)</b>	<b>0.86</b>	<b>0.99 (0.98; 1.00)</b>	<b>0.87</b>
Male sex (ref = female)	0.92 (0.75; 1.12)	0.92	1.00 (0.80; 1.25)	1.00
Body mass index	0.99 (0.98; 1.01)	0.97	0.99 (0.97; 1.01)	0.97
Current smoking (ref = no)	1.13 (0.87; 1.47)	1.13	1.02 (0.77; 1.34)	1.02
<b>Systemic comorbidity (ref = no)</b>				
Diabetes	0.97 (0.73; 1.29)	0.97	1.03 (0.76; 1.39)	1.03
Rheumatic autoimmune disease	1.30 (0.99; 1.70)	1.30	1.32 (1.00; 1.75)	1.32
Hypothyroidism	0.91 (0.62; 1.35)	0.91	0.98 (0.66; 1.47)	0.98
<b>Type of work (ref = unemployed)</b>				
Light physical labor	1.10 (0.87; 1.39)	1.10	1.04 (0.80; 1.35)	1.04
Moderate physical labor	1.19 (0.94; 1.51)	1.19	1.07 (0.82; 1.41)	1.07
Heavy physical labor	0.96 (0.69; 1.34)	0.96	0.83 (0.58; 1.20)	0.83
<b>Clinical characteristics</b>				
Dominant hand affected (ref = no)	<b>1.37 (1.13; 1.66)</b>	<b>1.37</b>	<b>1.34 (1.10; 1.63)</b>	<b>1.34</b>
<b>Affected digit (ref = thumb)</b>				
Index finger	<b>1.74 (1.21; 2.49)</b>	<b>1.74</b>	<b>1.65 (1.14; 2.40)</b>	<b>1.65</b>
Middle finger	<b>2.01 (1.59; 2.55)</b>	<b>2.01</b>	<b>2.01 (1.56; 2.58)</b>	<b>2.01</b>
Ring finger	1.19 (0.91; 1.56)	1.19	1.22 (0.92; 1.62)	1.22
Little finger	1.01 (0.62; 1.66)	1.01	1.06 (0.64; 1.76)	1.06
Duration of symptoms in (mo)	<b>1.01 (1.01; 1.02)</b>	<b>1.17</b>	<b>1.01 (1.00; 1.01)</b>	<b>1.09</b>
Flexion contracture (ref = no)	1.20 (0.92; 1.57)	1.20	1.25 (0.95; 1.65)	1.25
<b>Number of steroid injections (ref = 0)</b>				
1 injection	<b>1.41 (1.14; 1.75)</b>	<b>1.41</b>	1.22 (0.97; 1.54)	1.22
2 injections	<b>1.55 (1.18; 2.04)</b>	<b>1.55</b>	1.33 (1.00; 1.78)	1.33
≥3 injections	<b>4.13 (2.59; 6.57)</b>	<b>4.13</b>	<b>3.22 (1.99; 5.23)</b>	<b>3.22</b>
Injection <3 mo before surgery (ref = no)	<b>2.07 (1.53; 2.80)</b>	<b>2.07</b>	<b>2.02 (1.46; 2.79)</b>	<b>2.02</b>
<b>Patient-reported outcome measures</b>				
MHQ Pain	0.99 (0.99; 1.00)	0.89	1.00 (0.99; 1.00)	0.91
MHQ Hand function	1.00 (0.99; 1.00)	0.92	1.00 (0.99; 1.01)	1.00

Results are presented as unstandardized OR with 95% CI and SOR. Bold values denote statistically significant *P*-values (*P* < .05). CI, confidence interval; MHQ, Michigan Hand outcome Questionnaire; OR, odds ratios.

from impaired function of these digits and consequently more often opt for additional treatment.

In contrast to our study, previous studies found that several patient characteristics, such as a male sex,<sup>15</sup> diabetes,<sup>9,12,31,32</sup> and current smoking<sup>31,33</sup> were associated with a higher risk of complications. A possible explanation for these differences is that we assessed risk factors for all types of complications, whereas other studies assessed specific complications. For example, consistent with our findings, Stepan et al<sup>34</sup> demonstrated no association between diabetes and overall complications. However,

Bruijnzeel et al<sup>12</sup> found that diabetes was highly associated with specific complications, including recurrence and suture related problems, such as a suture abscess. Furthermore, in contrast to the study of Bruijnzeel et al<sup>12</sup> we excluded patients with multiple trigger digits in this study. As prior literature has shown that multiple trigger digits occur more often in patients with diabetes, are more difficult to treat, and yield a higher risk for complications,<sup>9,35–37</sup> it is plausible that the association between diabetes and complications may be stronger in patients with multiple trigger digits.



**FIGURE 2:** Forest plot of all variables that were significantly associated with complications in the multivariable logistic regression models for all complications and the different complication grades. Results are presented as standardized odds ratios (dots) and 95% confidence intervals (horizontal lines). The vertical line represents the ‘no effect’ line. This figure shows that  $\geq 3$  preoperative steroid injections and a steroid injection within 3 months before surgery were the most influential factors associated with postoperative complications. MHQ, Michigan Hand Outcome Questionnaire.

Despite the strengths of our study, including a large study sample and a standardized complication registration tool, several limitations also should be considered. First, the observational design is associated with a substantial number of patients who did not complete the baseline questionnaires. Second, all medical records were reviewed retrospectively for information about complications, a preoperative flexion contracture, and the number of preoperative steroid injections, since this information is not collected routinely in our outcome measurement system. Although complications in general were described comprehensively, there could be an underestimation of complications that are not documented, especially if the complication is mild, or if the patient has sought care elsewhere. To account for an underestimation of the number of steroid injections, we excluded patients with an unknown number of prior steroid injections. Although the absence of a flexion contracture was not always reported properly, we did not exclude these patients because this may lead to selection bias. However, the absence of preoperative range of motion measures and the possible underestimation of preoperative flexion contractures may have resulted in an overestimation of limited range of motion grade 1 complications. Third, a relatively large proportion of the variation in outcomes remains unexplained, suggesting that there may be other influential factors not

included in our analysis. For example, previous studies found that general anesthesia and hypoglycemia were associated with postoperative complications.<sup>15,38</sup> However, in contrast to the study of Everding et al<sup>15</sup> in which 59% of patients underwent additional procedures, we only included patients undergoing A1 pulley release of a single digit because of the nature of our database (i.e., if a patient receives multiple treatments at the same time, the patient will be assigned only to the track including the most extensive treatment<sup>20</sup>). Hence, as general anesthesia is a rare indication for A1 pulley release of a single digit, we did not include this factor in our analysis. Another explanation may be that we combined different complication types within the complication grades. It is plausible that factors associated with complications differ between specific complications. Future studies should examine factors contributing to these specific complications.

This study demonstrates that  $\geq 3$  preoperative steroid injections and a steroid injection within 3 months before surgery were the most influential factors contributing to postoperative complications. These findings can assist clinicians during patient counseling and may guide preoperative treatment. We recommend that clinicians should consider avoiding steroid injections within 3 months before surgical A1 pulley release and to be reluctant in performing  $>2$  steroid injections.



**TABLE 5. Multivariable Logistic Regression Analysis for the Different Complication Grades**

	Grade 1		Grade 2		Grade 3	
	Univariable	Multivariable	Univariable	Multivariable	Univariable	Multivariable
<b>Patient characteristics</b>						
Age (y)	<b>0.99 (0.97; 1.00)</b>	0.99 (0.97; 1.00)	<b>0.99 (0.97; 1.00)</b>	0.99 (0.98; 1.00)	0.98 (0.96; 1.00)	0.98 (0.96; 1.01)
Male sex (ref = female)	0.81 (0.60; 1.10)	0.90 (0.64; 1.26)	1.00 (0.76; 1.32)	1.06 (0.78; 1.44)	0.95 (0.57; 1.59)	1.14 (0.64; 2.01)
Body mass index	0.98 (0.95; 1.01)	0.98 (0.95; 1.02)	1.00 (0.98; 1.02)	1.00 (0.98; 1.03)	1.00 (0.96; 1.04)	0.99 (0.94; 1.05)
Current smoking (ref = no)	1.38 (0.95; 1.99)	1.23 (0.84; 1.80)	0.98 (0.67; 1.43)	0.89 (0.60; 1.32)	0.97 (0.48; 1.98)	0.79 (0.38; 1.66)
<b>Systemic comorbidity (ref = no)</b>						
Diabetes	0.90 (0.57; 1.40)	1.02 (0.64; 1.62)	0.99 (0.66; 1.48)	1.01 (0.66; 1.54)	1.14 (0.56; 2.31)	1.03 (0.49; 2.17)
Rheumatic autoimmune disease	1.41 (0.96; 2.08)	1.44 (0.96; 2.16)	1.27 (0.88; 1.85)	1.41 (0.95; 2.09)	1.03 (0.49; 2.18)	0.93 (0.43; 2.01)
Hypothyroidism	1.03 (0.59; 1.80)	1.11 (0.62; 1.97)	0.75 (0.41; 1.36)	0.81 (0.44; 1.50)	1.16 (0.46; 2.93)	1.38 (0.53; 3.60)
<b>Type of work (ref = unemployed)</b>						
Light physical labor	1.12 (0.80; 1.58)	1.08 (0.74; 1.57)	1.19 (0.86; 1.64)	1.13 (0.79; 1.62)	0.72 (0.35; 1.45)	0.69 (0.33; 1.48)
Moderate physical labor	1.06 (0.74; 1.52)	0.93 (0.62; 1.39)	1.19 (0.85; 1.66)	1.16 (0.79; 1.70)	1.61 (0.91; 2.85)	1.54 (0.80; 2.97)
Heavy physical labor	0.74 (0.43; 1.28)	0.67 (0.37; 1.20)	1.08 (0.68; 1.70)	0.95 (0.58; 1.58)	1.25 (0.56; 2.78)	1.15 (0.48; 2.76)
<b>Clinical characteristics</b>						
Dominant hand affected (ref = no)	<b>1.57 (1.17; 2.11)</b>	<b>1.50 (1.11; 2.02)</b>	<b>1.37 (1.05; 1.80)</b>	<b>1.37 (1.04; 1.80)</b>	0.90 (0.55; 1.45)	0.94 (0.57; 1.55)
<b>Affected digit (ref = thumb)</b>						
Index finger	0.71 (0.33; 1.53)	0.66 (0.30; 1.42)	<b>2.29 (1.46; 3.58)</b>	<b>2.30 (1.44; 3.67)</b>	<b>2.99 (1.28; 6.99)</b>	<b>2.83 (1.17; 6.85)</b>
Middle finger	<b>2.07 (1.45; 2.95)</b>	<b>1.99 (1.37; 2.90)</b>	<b>1.84 (1.33; 2.56)</b>	<b>1.87 (1.32; 2.65)</b>	<b>2.59 (1.37; 4.93)</b>	<b>2.70 (1.37; 5.34)</b>
Ring finger	1.40 (0.94; 2.07)	1.38 (0.91; 2.08)	0.97 (0.65; 1.43)	1.00 (0.67; 1.51)	1.50 (0.72; 3.12)	1.79 (0.83; 3.85)
Little finger	1.58 (0.84; 2.97)	1.60 (0.83; 3.06)	0.68 (0.31; 1.51)	0.73 (0.32; 1.64)	0.45 (0.06; 3.46)	0.62 (0.08; 4.81)
Duration of symptoms (mo)	<b>1.01 (1.01; 1.02)</b>	<b>1.01 (1.00; 1.02)</b>	<b>1.01 (1.00; 1.02)</b>	1.00 (0.99; 1.01)	1.01 (0.99; 1.02)	1.00 (0.99; 1.02)
Flexion contracture (ref = no)	0.78 (0.49; 1.24)	0.79 (0.49; 1.27)	1.38 (0.97; 1.97)	<b>1.52 (1.05; 2.21)</b>	<b>2.03 (1.13; 3.65)</b>	<b>2.05 (1.12; 3.77)</b>

(Continued)

TABLE 5. Multivariable Logistic Regression Analysis for the Different Complication Grades (Continued)

	Grade 1		Grade 2		Grade 3	
	Univariable	Multivariable	Univariable	Multivariable	Univariable	Multivariable
Number of steroid injections (ref = 0)						
1 injection	1.14 (0.83; 1.57)	1.02 (0.73; 1.43)	<b>1.83 (1.33; 2.50)</b>	<b>1.62 (1.16; 2.25)</b>	1.13 (0.66; 1.94)	0.90 (0.50; 1.62)
2 injections	1.39 (0.93; 2.08)	1.17 (0.77; 1.78)	<b>2.03 (1.38; 2.98)</b>	<b>1.81 (1.20; 2.72)</b>	0.80 (0.36; 1.79)	0.64 (0.28; 1.48)
≥3 injections	<b>4.30 (2.32; 7.98)</b>	<b>3.37 (1.76; 6.43)</b>	<b>3.93 (2.01; 7.71)</b>	<b>3.20 (1.58; 6.49)</b>	<b>4.13 (1.52; 11.19)</b>	<b>2.95 (1.02; 8.52)</b>
Injection <3 mo before surgery (ref = no)	1.22 (0.72; 2.08)	1.31 (0.75; 2.30)	<b>2.73 (1.87; 3.98)</b>	<b>2.38 (1.59; 3.57)</b>	<b>2.60 (1.31; 5.18)</b>	<b>3.15 (1.47; 6.75)</b>
Patient-reported outcome measures						
MHQ pain	0.99 (0.99; 1.00)	1.00 (0.99; 1.00)	1.00 (0.99; 1.00)	1.00 (0.99; 1.00)	<b>0.99 (0.97; 1.00)</b>	0.99 (0.98; 1.01)
MHQ hand function	1.00 (0.99; 1.00)	1.00 (0.99; 1.01)	1.00 (0.99; 1.01)	1.00 (1.00; 1.01)	<b>0.98 (0.96; 0.99)</b>	<b>0.98 (0.97; 1.00)</b>

Results are presented as unstandardized ORs (with 95% CI). Bold values denote statistically significant  $P$ -values ( $P < .05$ ). CI, confidence interval; MHQ, Michigan Hand outcome Questionnaire; OR, odds ratio.

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