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Does the AO/OTA fracture classification dictate the anesthesia modality for the surgical management of unstable distal radius fractures? A retrospective cohort study in 127 patients managed by general vs. regional anesthesia

Sascha Halvachizadeh^{1,2*†}, Merav Dreifuss^{1,2†}, Thomas Rauer^{1,2}, Anne Kaiser^{1,2}, Dirk Uebmann^{1,2}, Hans-Christoph Pape^{1,2} and Florin Allemann^{1,2}

Abstract

Introduction Regional anesthesia increases in popularity in orthopaedic surgery. It is usually applied in elective surgeries of the extremities. The aim of this study was to assess indication of the use of general anesthesia in the surgical treatment of distal radius fractures.

Methods Patients undergoing surgical fixation for distal radius fractures between January 1st, 2020, and December 31st, 2021, were included. Exclusion criteria encompassed incomplete 12-month follow-up, transferred or multiply injured patients, those with prior upper limb fractures, or admission for revision surgeries. Patients were categorized by anesthesia type: GA or plexus block anesthesia (PA). Primary outcomes comprised tourniquet utilization and duration of surgery, while secondary outcomes encompassed complications (e.g., complex regional pain syndrome [CRPS], local wound infection, implant removal necessity) and range of motion at three, six, and twelve months post-surgery. Fractures were classified using the AO/OTA system.

Results The study enrolled 127 patients, with 90 (70.9%) in Group GA and 37 (29.1%) in Group PA. Mean patient age was 56.95 (\pm 18.59) years, with comparable demographics and fracture distribution between groups. Group GA exhibited higher tourniquet usage (96.7% vs. 83.8%, $p=0.029$) and longer surgery durations (85.17 ± 37.8 min vs. 65.0 ± 23.0 min, $p=0.013$). Complication rates were comparable, Group GA 12.2% versus Group PA 5.4% $p=0.407$,

[†]Sascha Halvachizadeh and Merav Dreifuss contributed equally to this work.

*Correspondence:
Sascha Halvachizadeh
sascha.halvachizadeh@usz.ch

Full list of author information is available at the end of the article



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OR 2.44; 95%CI 0.51 to 11.58, $p=0.343$). Short-term functional outcomes favored Group PA at three months (e.g., Pronation: $81.1^\circ \pm 13.6$ vs. $74.3^\circ \pm 17.5$, $p=0.046$).

Conclusion Solely classifying distal radius fractures does not dictate anesthesia choice. Complexity of injury, anticipated surgery duration, less use of tourniquet, and rehabilitation duration may guide regional anesthesia utilization over GA in distal radius fracture fixation.

Keywords Distal radius fracture, Anesthesia, General anesthesia, Regional anesthesia, Perioperative management distal radius fracture

Introduction

Distal radius fractures stand as one of the most prevalent injuries encountered in adults [1]. Their surgical management hinges on various factors including fracture morphology, associated injuries, and patient-specific considerations [2, 3]. Surgical interventions for distal radius fractures commonly involve either general anesthesia or local anesthesia techniques such as wide-awake local anesthesia without a tourniquet or plexus block [4, 5]. In recent decades, there has been a noticeable surge in the utilization of regional anesthesia methods [6, 7].

Recent meta-analyses have underscored the comparability of regional anesthesia and general anesthesia concerning pain control and radiological outcomes [6]. Other studies reported a significantly shorter time in the recovery room in patients with regional anesthesia and significantly less use of opioids and antiemetic agents [8, 9]. However, conflicting findings persist regarding the optimal anesthesia modality for distal radius fracture treatment. While short-term pain relief appears superior with regional anesthesia, reports indicate converging pain statuses after a few days [10]. Likewise, patient satisfaction outcomes remain contentious, with some studies indicating higher satisfaction with regional anesthesia immediately post-surgery [11], while others highlight dissatisfaction stemming from prolonged postoperative limb insensitivity [12]. Novel approaches such as the use of virtual reality (VR) goggles for distraction can contribute significantly to patient satisfaction in combination during surgeries performed under regional anesthesia. This leads to a substantial reduction in anxiety and stable hemodynamics [13].

Consequently, the optimal choice of anesthesia for surgical interventions on distal radius fractures remains a subject of debate. Hence, this study aims to address the pivotal research question: What factors are associated with the use of general anesthesia in the surgical management of complex distal radius fractures?

Methods

The research protocol for this retrospective cohort study received approval from the local ethics committee (BASEC 2018–00146), and reporting adhered strictly to

the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [14].

Setting

This study was conducted at an academic trauma center. Adult patients who underwent surgical fixation for distal radius fractures between January 1st, 2020, and December 31st, 2021 were eligible for inclusion. Follow-up assessments were conducted at three, six, and twelve months post-surgery during routine outpatient clinic visits. Data were extracted from electronic medical records, encompassing information collected as part of routine clinical care.

Participants

Inclusion criteria comprised adult patients presenting with acute distal radius fractures at the Level 1 trauma center who underwent surgical fixation under either general or plexus block anesthesia. Exclusion criteria encompassed incomplete follow-up, secondary transfers, multiple injuries, prior upper limb fractures, or admission for revision surgeries.

Endpoints

The primary endpoint of this study were factors that decide the type of anesthesia that might reflect the complexity of injury: duration of surgery, usage of tourniquet during surgery, and functional recovery during follow-up. Secondary outcome parameters included complications such as complex regional pain syndrome [CRPS], local wound infection, or implant removal necessity.

Variables and definitions

Anesthesia protocols were standardized within the department of anesthesiology, with general anesthesia and regional anesthesia administered according to institutional guidelines. Fractures were managed using volar plating following a palmar incision via the modified Henry approach. Complications, including CRPS, were diagnosed by treating surgeons according to the Veldman criteria [15]. Range of motion assessments were conducted during routine outpatient follow-up by a senior attending. Fractures were classified according to the AO/OTA classification system [16].

Anesthesia protocol

For general anesthesia, patients were positioned supine with basic monitoring and intravenous access established. Propofol and opioid were administered for induction, followed by muscle relaxants for airway preparation. Propofol infusion and opiates were utilized for anesthesia maintenance and pain control, respectively. For plexus block anesthesia, patients were positioned supine with the arm abducted to 90°. Ultrasound-guided nerve identification preceded nerve block administration using local anesthetics. Additional sedation was provided intra-operatively as necessary.

Bias mitigation

Strict inclusion criteria were implemented to reduce bias, limiting enrollment to primary acute fractures. All patients received treatment from a single senior attending to minimize treatment bias, and range of motion assessments were conducted by the same attending to reduce heterogeneity.

Statistics

Continuous variables were presented as mean \pm standard deviation (SD), while categorical variables were reported as counts and percentages. Group comparisons were performed using Student's *t*-test for normally distributed continuous variables and chi-squared test for categorical

variables. Patients were stratified into Group GA (general anesthesia) and Group PA (plexus block anesthesia). A formal sample size calculation was not performed, since this study included the maximum dataset of available data. However, a power fisher test was performed with the rate of complications as the primary outcome and the number of patients per group as the sample size. Statistical significance was set at $\alpha=0.05$. Statistical analyses were conducted using R software. (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>)

Results

Participants

Out of 259 eligible patients, 127 (49.0%) met the inclusion criteria, with 90 (70.9%) stratified into Group GA and 37 (29.1%) into Group PA (Fig. 1). The mean age of the participants was 56.95 years (SD 18.59), with a predominance of females ($n=94$, 74.0%). Fracture distribution revealed a majority of AO/OTA Type A fractures ($n=54$, 42.5%) and Type C fractures ($n=60$, 47.2%), and a minority of AO/OTA Type B fractures ($n=13$, 10.2%). Group GA exhibited a slightly older mean age compared to Group PA. However, both groups demonstrated comparable body mass index (BMI), distribution of AO/OTA classification, and percentages of smokers (Table 1).

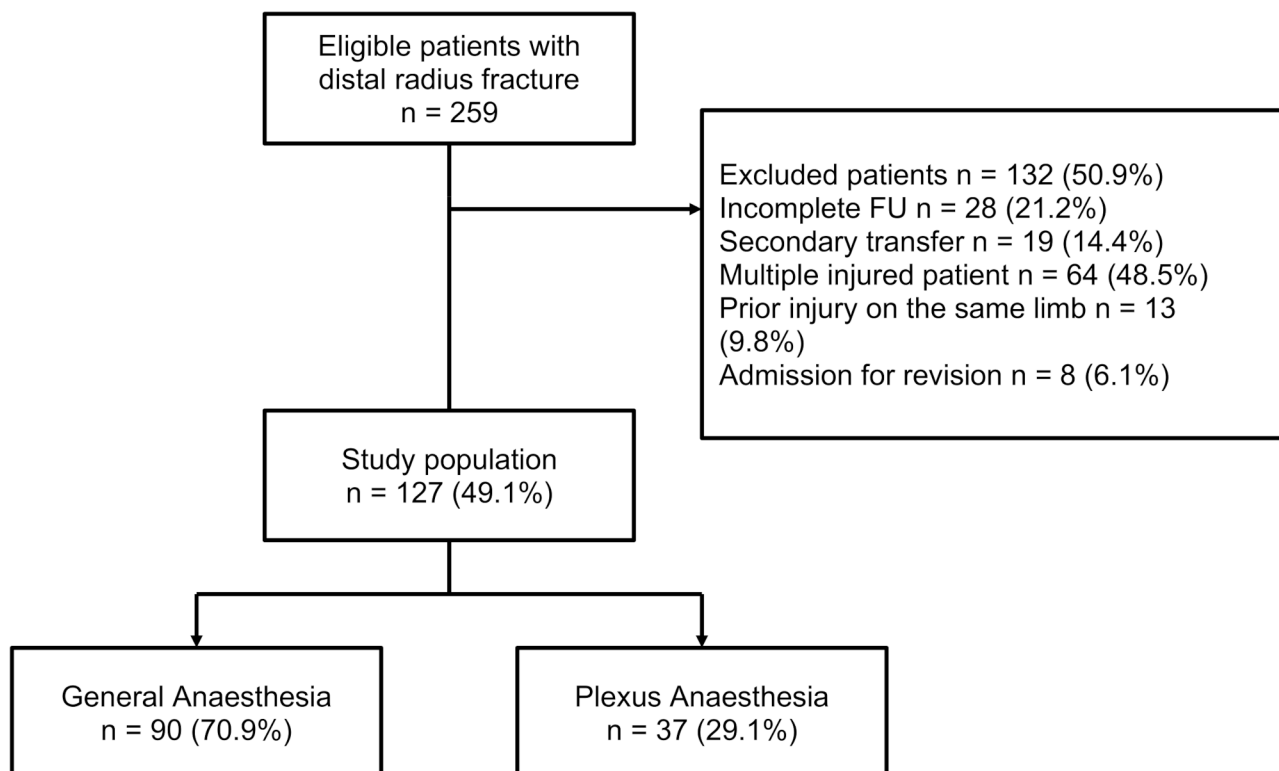


Fig. 1 Flow diagram of eligible patients, exclusions, resulting in the study population

Table 1 Descriptive characteristics of the study population

	General anesthesia	Plexus anesthesia	p-value
<i>n</i>	90	37	
Age [years], mean (SD)	58.94 (18.3)	52.11 (18.6)	0.059
Gender [female], <i>n</i> (%)	66 (73.3)	28 (75.7)	0.959
BMI [kg/m ²], mean (SD)	24.95 (4.6)	24.79 (4.8)	0.865
AO/OTA-Classification, <i>n</i> (%)			0.508
A	37 (41.1)	17 (45.9)	
B	11 (12.2)	2 (5.4)	
C	42 (46.7)	18 (48.6)	
Smoker, <i>n</i> (%)	12 (13.3)	4 (10.8)	0.811

n = number; BMI = body mass index; SD = standard deviation

Perioperative course

The mean duration of surgery was 75.1 min (SD 30.4). A tourniquet was used in the majority of cases ($n=118$, 92.9%), with an average inflation time of 72.09 min (SD 31.75). Fluoroscopy was used for an average of 143.5 s (SD 147.05), with a mean radiation dosage of 2.12 mGray (SD 2.32). The overall length of hospital stay averaged 5.26 days (SD 2.68). Tourniquet use was significantly more frequent in Group GA ($n=87$, 96.7%) compared to Group PA ($n=31$, 83.3%, $p=0.029$). Additionally, the duration of tourniquet inflation was higher in Group GA compared to Group PA (75.51 min, SD 29.9 vs. 63.76 min, SD 34.75, 95% CI -1.3 to 24.8, $p=0.076$). Surgery duration was significantly longer in Group GA compared to Group PA (85.2 min, SD 37.8 vs. 65.0 min, SD 23.0, $p=0.013$) (Table 2).

Complications and range of motion

Overall, 13 complications (10.2%) were reported. The rate of complications was comparable in both groups (12.2% in Group GA versus 5.4% Group PA, 95% CI in proportion -0.3 to 0.436, $p=0.407$). The Odds ratio for the development of complications was 2.44 (95%CI 0.51 to 11.58, $p=0.343$).

Pain was the most common reported complication ($n=10$, 7.8%). This included Complex Regional Pain Syndrome (CRPS) ($n=5$, 3.9%) and persistent pain lasting more than 3 months ($n=5$, 3.9%). Other complications included implant loosening ($n=4$, 3.1%), implant removal

within 6 months ($n=3$, 2.4%), and tendon injury ($n=1$, 0.8%). The overall complication rate was comparable between Group GA and Group PA. However, Group GA had a higher incidence of CRPS compared to Group PA (6.1% vs. 0%) and a higher rate of persistent pain (4.9% vs. 2.7%) (Table 3). The power calculation yielded a power of 62.7%.

Range of motion was significantly better in Group PA at the three-month follow-up compared to Group GA: Pronation: 81.1° (SD 13.6) vs. 74.3° (SD 17.5), $p=0.046$; Radial deviation: 21.9° (SD 10.9) vs. 17.6° (SD 7.2), $p=0.017$; Ulnar deviation: 26.7° (SD 9.8) vs. 22.9° (SD 8.9), $p=0.05$. Range of motion during the 12-month follow-up period was similar in both groups, with observed improvements in both (Fig. 2).

Discussion

The present study provides valuable insights into the impact of anesthesia type on perioperative variables and short-term functional outcomes in the surgical management of complex distal radius fractures. Our findings underscore the importance of considering fracture complexity and anticipated prolonged rehabilitation when selecting anesthesia modalities. Patients with complex distal radius fractures present unique challenges during surgical fixation, necessitating careful consideration of anesthesia options [2, 17]. Previous studies have reported varying functional outcomes based on anesthesia type [6, 18]. However, these studies often overlook the complexity

Table 2 Perioperative course stratified according to type of anaesthesia

	General anaesthesia	Plexus anesthesia	p-value
<i>n</i>	90	37	
Use of tourniquet, <i>n</i> (%)	87 (96.7)	31 (83.8)	0.029
Duration tourniquet [min], mean (SD)	75.51 (29.9)	63.76 (34.8)	0.076
Intraoperative screw-revision, <i>n</i> (%)	14 (15.6)	4 (10.8)	0.677
Duration Fluoroscopy usage [sec.], mean (SD)	148.46 (158.8)	132.14 (117.1)	0.62
Radiation dose [mGray], mean (SD)	2.30 (2.6)	1.71 (1.5)	0.261
Length of stay [days], mean (SD)	5.48 (2.8)	4.73 (2.3)	0.154
Surgery duration [min], mean (SD)	85.2 (37.8)	65.0 (23.0)	0.013

n = number; SD = standard deviation; Surgery duration was measured as the time from skin incision to skin closure

Table 3 Rate of complications stratified according to method of anaesthesia

	General anaesthesia	Plexus anaesthesia	p-value
n	90	37	
Complications, n (%)	11 (12.2)	2 (5.4)	0.407
CRPS	5 (6.1)	0 (0.0)	
Requirement of implant removal within 6 months	2 (2.4)	1 (2.7)	
Implant loosening	3 (3.7)	1 (2.7)	
Tendon injury	1 (1.2)	0 (0.0)	
Persistent Pain for more than 3 months	4 (4.9)	1 (2.7)	

n = number; SD = standard deviation; CRPS = complex regional pain syndrome

and severity of the fractures, which significantly influence surgical planning and rehabilitation duration [19]. In our study, a slightly higher proportion of type C fractures according to the OA/OTA classification were treated in the plexus anesthesia (PA) group (48.6%) compared to the general anesthesia (GA) group (46.7%). Notably, the PA group demonstrated significantly lower usage of a tourniquet. This finding aligns with broader research indicating that tourniquet use may negatively impact postoperative pain and functional recovery in orthopedic surgeries [20]. Despite our study's smaller sample size, similar trends were observed for distal radius fractures. Currently, there is limited research directly comparing the incidence of Complex Regional Pain Syndrome (CRPS) following distal radius fractures based on the type of anesthesia used during surgical treatment. While some studies have explored the incidence and risk factors associated with CRPS in distal radius fractures, they do not specifically address the impact of anesthesia type. For instance, a meta-analysis reported an overall CRPS incidence of 13.63% in radius fractures and identified risk factors such as fracture complexity, female sex, high body mass index, and psychiatric disorders, but did not examine anesthesia type as a variable [21]. Similarly, a survey assessed current practices regarding CRPS after distal radius fractures among orthopedic surgeons but did not provide data correlating anesthesia type with CRPS incidence [22]. These results are in accordance to the present study indicating complexity of fracture as risk factor for the development of CRPS.

Furthermore, follow-up examinations revealed comparable wrist mobility. Our findings suggest that neither short-term nor long-term functional outcomes are significantly impacted by the choice of anesthesia. While factors such as surgical duration and intraoperative management may differ between anesthesia types, these variations do not appear to translate into differences in functional recovery at either early or later stages. This aligns with existing literature, which indicates that the type of anesthesia has limited influence on the overall trajectory of functional outcomes, reinforcing the importance of individualized anesthesia selection based on patient and procedural needs [23]. Our findings also

underscore that the choice of anesthesia should be tailored to the complexity of the fracture and the expected rehabilitation trajectory. While plexus block anesthesia may offer advantages in promoting early range of motion, especially in less complex fractures [24, 25], the decision should be individualized based on patient-specific factors and surgical requirements. For instance, operations with an average duration of 75 min can be effectively managed under plexus anesthesia, with options for patient comfort such as distraction techniques or light sedation.

Limitations

A key limitation of this study is its retrospective design, which inherently relies on pre-existing data and is subject to potential biases, such as selection bias and incomplete documentation. This design limits the ability to establish causal relationships and control for confounding variables, which may affect the interpretation of findings. The lack of confounding factors such as patients comorbidities might also attribute to the choice of anesthesia. The rationale behind the selection of specific anesthesia methods for individual patients was not documented. That might potentially introduce bias and limit our understanding of anesthesia selection factors in distal radius fracture surgery. Standardized functional outcome scores were not consistently assessed, which limits the depth of our analysis compared to studies with more comprehensive functional assessments. Furthermore, our study may be susceptible to a type 2 error due to its relatively small sample size, power of 62.6% and a high dropout rate of 50.9%. This dropout rate was influenced by various factors, including incomplete follow-up and patient transfers, which may have introduced confounding variables and impacted data interpretation. Further the lack of data on potential confounding factors, such as surgical team decision-making dynamics may have influenced the choice of anesthesia and contributed to differences in surgical and tourniquet times. Additionally, the retrospective nature of the study precludes assessment of whether the use of general anesthesia was associated with the perception of having more time for teaching or complex case execution. Despite these limitations, our

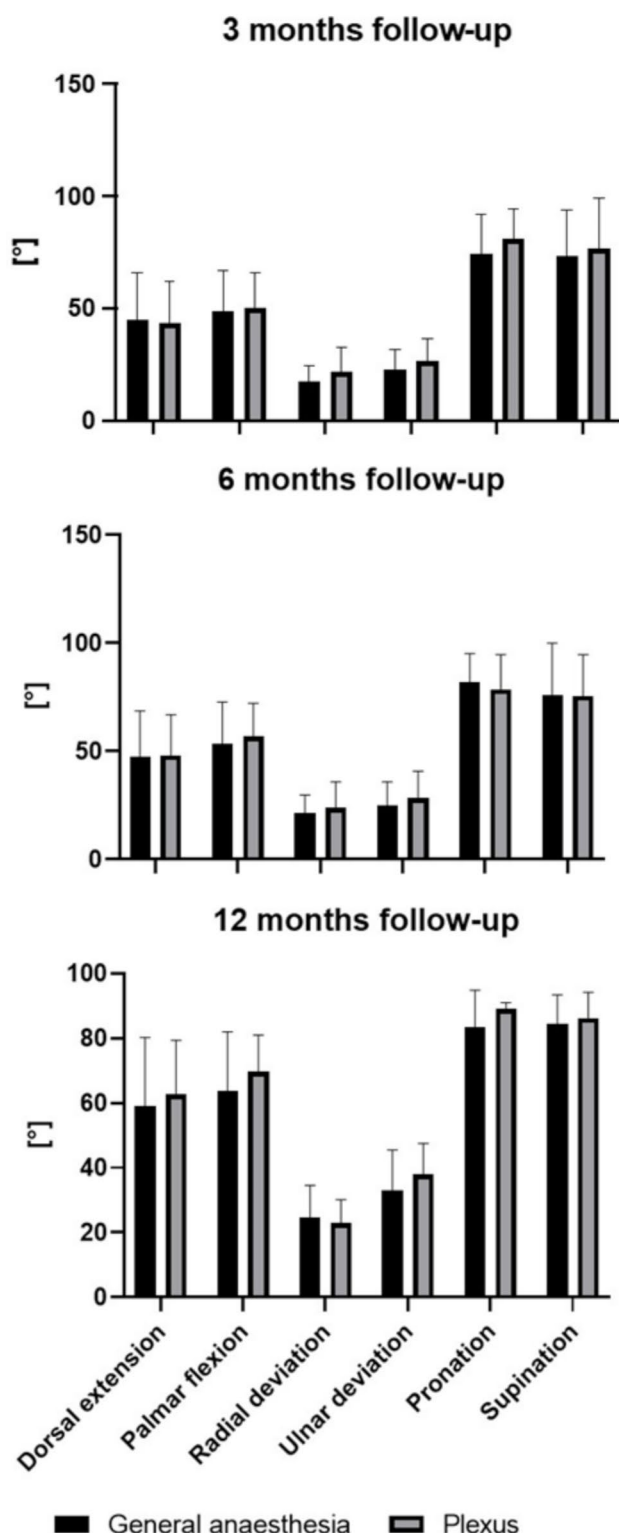


Fig. 2 Range of motion improved over the course of the follow-up period. The range of motion was not associated with the type of anesthesia

findings are consistent with clinical experiences reported in the literature.

Conclusion

This study supports the idea that anesthesia selection for distal radius fractures should consider the complexity of the injury and anticipated rehabilitation needs. General anesthesia may be preferable for more complex fractures requiring extensive surgical intervention and prolonged operative times, taking into account patient preferences. Clinicians should carefully weigh the advantages and disadvantages of each anesthesia modality to optimize outcomes and facilitate effective rehabilitation. Future research should further explore these associations with larger sample sizes and longer-term follow-ups to validate our findings.

Author contributions

S.H., M.D., contributed equally to this work. S.H., M.D., H.C.P. and F.A. collected the data, analyzed and interpreted the data, prepared the figures and tables, wrote the main manuscript; H.C.P. and F.A. additionally supervised the study; T.R., A.K. and D.U. critically rewrote the manuscript, analyzed and interpreted the data, and were substantially involved in the patients treatment. A.K., D.U. additionally collected the anesthesiologic data and interpreted the results from anesthesiologic point. All authors reviewed the final manuscript and have approved the submitted version.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The cantonal ethics committee approved this study under the reference number BASEC 2018-00146 and waived the necessity for additional informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department of Trauma, University Hospital Zurich, Raemistrasse 100, Zurich 8091, Switzerland

²University of Zurich, Rämistrasse 71, Zürich 8006, Switzerland

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