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The difference between general anesthesia and peripheral nerve block in terms of postoperative functional recovery after orthopaedic upper limb surgery: Systematic review

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ABSTRACT

Background: Following upper limb procedures, a significant percentage of patients report moderate to severe postoperative pain, and they also tend to consume more opioids over 24 hours following the procedure. We carried out a systematic review of papers evaluating the effects of peripheral nerve block vs GA on functional recovery following upper limb surgery. *Method:* The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was followed in the conduct of this investigation. Our comprehensive search approach used CENTRAL, MEDLINE, Scopus, and EMBASE from January 2012 to September 2024. Serch terms include, Brachial plexus, peripheral anesthesia, upper limb surgery, FR, nerve block, and postoperative recovery. *Result:* Five papers were included in this review. Three studies employed supraclavicular nerve block, while one study used infraclavicular block to assess wrist clinical results. Among the surgical indications were distal radial fracture fixation, ischemia after tourniquet-induced upper limb surgery, and wrist surgeries (including carpal tunnel release, ganglion cyst excision, wrist mass excision, metacarpal fracture, hardware removal, fracture correction, arthroscopic surgery, and ligament repair). *Conclusion:* Early postoperative brachial plexus block pain management did not significantly vary from general anesthesia in patients undergoing orthopedic forearm surgery or surgical stabilization of distal radial fractures.

Keywords: General anesthesia, peripheral nerve block, functional recovery, upper limb surgery

1. INTRODUCTION

Over 70% of patients experience moderate to severe postoperative pain after upper limb surgeries, and they also typically use more opioids on average 24 hours after surgery (Ekstein and Weinbroum, 2011; Ootes et al., 2012). Postoperative pain and inflammation after upper limb surgery (ULS) cause mechanical hyperalgesia and reduce range of motion in the operated joint, which slows healing (Ekstein and Weinbroum, 2011; Ootes et al., 2012). Remarkably, after ULS, 15–20% of patients report being less functional in daily life activities than they were before the procedure (Ludvigsen et al., 2021).

Postoperative discomfort may affect long-term functional recovery (FR) by postponing rehabilitation (Hah et al., 2021). In order to assess FR, it is crucial to incorporate patient-reported outcomes, as recent research has shown that RF is an interdisciplinary concept that pertains by the daily activities limitations, and personal and environmental factors (Jayakumar et al., 2017). Muscle strength, radiographic evidence of fracture union, psychometric evaluation measures, and articulation range of motion can all be used to gauge the operated limb FR after surgery (Jayakumar et al., 2017).

One method that avoids the negative consequences of general anesthesia while providing long-term analgesia is peripheral nerve block (PNB) (Jeng et al., 2010). Improved postoperative pain control, shorter hospital stays, decreased hospital expenses, and the avoidance of serious general anesthesia (GA) related problems are only a few benefits that local anesthetic offers over GA in orthopedics (Cozowicz et al., 2015). By blocking voltage-dependent sodium channels, the local anesthetic injection surrounding the nerve prevents pain signals from being neurotransmitted and causes motor immobility (Neal et al., 2009).

Additionally, local anesthetic drugs have a number of anti-inflammatory effects, including preventing sympathetic nerve activity, reducing cytokine release, and inhibiting C fiber activation. These mechanisms serve to minimize postoperative discomfort and encourage early limb movement (Kettner et al., 2011). However, little research has been done on how early mobilization and postoperative discomfort affect FR after ULS (Kettner et al., 2011). We conducted a systematic review of studies assessing the impact of PNB versus GA on FR after ULS in order to fill this vacuum in the literature.

2. METHOD

This study was conducted according to The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. From January 2012 to September 2024, we conducted a thorough search strategy using CENTRAL, MEDLINE, Scopus, and EMBASE. The following keywords were used in the search: Brachial plexus, peripheral anesthesia, upper limb surgery, FR, nerve block, and postoperative recovery. We considered observational studies and randomized controlled trials that evaluated the PNB use in ULS compared to GA. Studies were considered if the target group consisted of individuals having ULS. Studies contrasting brachial plexus PNB with GA—which includes supraclavicular, axillary, infraclavicular, and interscalene—were included.

We did not apply language constraints and only accepted studies that evaluated FR using upper limb psychometric test. Studies that were case reports, series, animal model experiments, or that did not compare GA with PNB were not included. Using pre-made data extraction forms, we carried out data extraction separately and twice. research title, first author, baseline characteristics, research design, intervention details, and pertinent controls were among the extracted data. Outcomes included were: Range of motion, FR, and patient satisfaction. We also collected available adverse events which include: vascular puncture, persistent pain, nerve damage, infection, or other injuries. Reviewers' disagreements were settled through dialogue or outside arbitration.

3. RESULT AND DISCUSSION

We included 5 articles in this review (Figure 1), Table 1 provides a summary of the study's features. One investigation used infraclavicular block to evaluate wrist clinical outcomes Egol et al., (2012) and three studies used Supraclavicular nerve block (Doo et al., 2020; Galos et al., 2016; Rundgren et al., 2019). Surgical indications included, distal radial fracture fixation Egol et al., (2012), Galos et al., (2016), Rundgren et al., (2019), and multiple wrist surgeries (such as carpal tunnel release, ganglion cyst excision, wrist mass

excision, metacarpal fracture, hardware removal, fracture correction, arthroscopic surgery, and ligament repair) Doo et al., (2020), and ischemia following ULS induced by tourniquet (Kutanis et al., 2024).

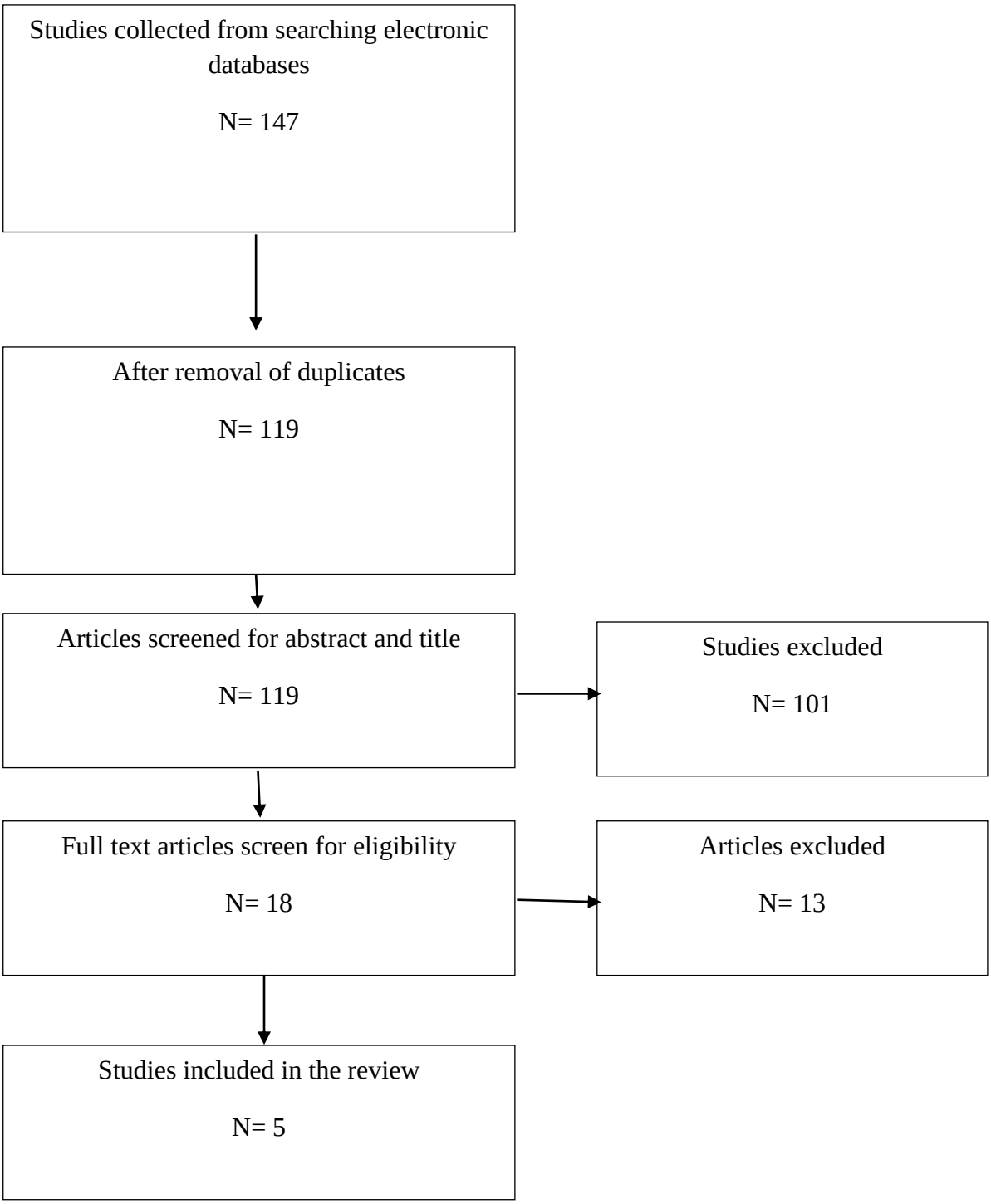

Figure 1 PRISMA consort chart of studies selection

Table 1 Included studies characteristics

Citation	Sample size	Study Design	Procedure	Peripheral Nerve Block
Doo et al., 2020	119	Prospective	Hand ware removal Fracture correction Tendon repair Arthroscopic surgery Mass excision Other Carpal tunnel release	Supraclavicular using lidocaine and epinephrine
Kutanis et al., 2024	92	Comparative study	Ischemia after ULS induced by tourniquet	Using bupivacaine and lidocaine in combination, an axillary block was performed under the guidance of a nerve stimulator and an ultrasound probe.
Galos et al., 2016	36	Randomized controlled trial	Fixation of distal radius fracture (DRF)	Peripheral Nerve Block group received infra clavicular nerve block with Lidocaine, epinephrine and Bupivacaine.
Rundgren et al., 2019	90	Randomized controlled trial	Fixation of DRF	Supraclavicular nerve block using mepicavaine and levobupivacaine
Egol et al., 2012	187	Retrospective	Fixation of DRF	Infra clavicular nerve block

Main findings of the included studies were presented in (Table 2). We examined five studies assessing the effects of anesthetic type on FR following ULS. Varied PNB kinds were utilized in individual trials, and varied research results were evaluated. Since early mobilization and postoperative pain reduction had an effect on lower limb FR, our initial hypothesis was that PNB would enhance postoperative FR when compared to GA (Carli et al., 2010; Kessler et al., 2015; Nader et al., 2012). According to one study, there may be a difference between GA and PNB in terms of FR (Egol et al., 2012). The high degree of variability seen in the studies that were part of this systematic review is the first possible explanation.

The most notable factors contributing to this clinical heterogeneity are the differences in the methods used to evaluate clinical outcomes, the joint in question, the surgical indication, and the timing of participant follow-up amongst the studies in this review. Acute, mild, and chronic conditions were among the factors that affected the surgical indication between studies (Doo et al., 2020; Egol et al., 2012; Galos et al., 2016; Rundgren et al., 2019). Because the pain intensity, duration, and recovery time are not comparable to those of an open reduction internal fixation vs a carpal tunnel release, the influence of the surgical indication must be taken into account (Hah et al., 2021; Niedermeier et al., 2021).

Furthermore, acute and chronic conditions have different levels of preoperative functioning (Cheema et al., 2020). A patient with a chronic disease would, in fact, have greater disability ratings prior to surgery (Cheema et al., 2020). This discrepancy might lead to a greater postoperative impairment score being persistent and a weaker correlation between the kind of anesthetic and FR. However, both acute and chronic illnesses were evaluated simultaneously in one investigation, no adjustments were done in this study to evaluate this restriction (Doo et al., 2020). The period of time between the operation and the assessment of FR may affect the outcomes and be a confounding factor, depending on the joint in question.

This would contribute to the non-statistical difference in the statistical analysis by weakening the correlation between the PNB and FR. Given our hypothesis that locoregional anesthetic reduces postoperative pain and inflammation, comparing various surgical

procedures may have affected the psychometric questionnaire answers and, as a result, limited the range of comparisons that could be made. This systematic review identifies several research challenges related to PNB and FR after ULS, including the variability and complexity of evaluating FR, as well as the length of recovery based on the type of surgery performed and the joint involved. Therefore, we believe that we might minimize variation and improve the evaluation of FR in this population by standardizing questionnaires and surgical indications.

Table 2 Main findings of the included studies

Citation	Main findings
Doo et al., 2020	At baseline and on the first and seventh days after surgery, there was no discernible difference in the pain scores between the two groups. Both the general and regional anesthetic groups' pain scores on the first postoperative day were substantially lower than those on the baseline and seventh postoperative days, respectively, according to a two-way ANOVA. At every timepoint, there was no discernible difference between the two groups, nevertheless.
Kutanis et al., 2024	Lactate levels and glucose levels at different time intervals were greater in the axillary block group than in the other groups. At different time intervals, Group A's ischemia-modified albumin levels were lower than those of the other groups. Furthermore, at different time intervals, the axillary block group's ischemia-modified albumin levels were lower than those of the GA group. At different time intervals, axillary block group I had greater levels of total antioxidant status than the other groups. Group A had lower levels of total oxidant status at different time intervals than axillary block group.
Galos et al., 2016	At two hours after surgery, patients under GA reported higher pain levels; at twelve and twenty-four hours, patients under brachial plexus blockade (BPB) reported higher pain scores. Patients who had GA spent more time in the recovery area, but there was no difference in the amount of time spent in the operating room. Compared to patients who got BPB, those who underwent GA used more fentanyl and morphine. At six and twelve weeks after surgery, there was no difference in the functional outcome ratings.
Rundgren et al., 2019	In the first three postoperative days, the GA group's total median opioid equivalent consumption was 85 mg, whereas the RA group's was 60 mg. During the first 24 hours following surgery, there were significant differences between the groups in terms of VAS for pain ratings. Compared to individuals in the RA group, GA patients group reported higher levels of discomfort both immediately following surgery and two hours afterward. In contrast to the RA group, which had maximum pain at a median of 11 hours following the conclusion of surgery, the GA group experienced maximum pain at a median of 1 hour.
Egol et al., 2012	Regarding patient demographics and fracture types treated, there were no differences between the groups. Patients who had a regional block experienced less pain three and six months after surgery. At every follow-up point, individuals who got regional anesthetic as opposed to GA had better wrist and finger range of motion. According to the Disabilities of the Arm, Shoulder, and Hand at three and six months, patients who underwent regional anesthetic also scored higher on functional tests.

4. CONCLUSION

In patients having orthopedic forearm surgery or surgical stabilization of DRFs, BPB pain management during the early perioperative phase did not differ substantially from GA. During tourniquet-assisted upper extremity surgery, axillary anesthesia produces a sympathetic block, which improves upper extremity circulation following ischemic reperfusion injury.

Ethical approval
Not applicable.

Informed consent
Not applicable.

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Conflict of interest
The authors declare that there is no conflict of interests.

Data and materials availability
All data sets collected during this study are available upon reasonable request from the corresponding author.

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