

Original Article: Analgesic effect of intravenous dexamethasone after volar plate surgery for distal radius fracture: systematic review

Parham Maroufi¹, Mahdi Nazari²®

Associated Professor of Orthopedics, Department of Orthopedics, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran. (Email: p_maroufi@yahoo.com- ORCID: 0000-0002-1357-7795)

Assistant Professor of Anesthesiology, Department of Anesthesiology, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran. (Corresponding ORCID: 0000-0001-9982-4867)



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ABSTRACT

Introduction: This systematic review aims to evaluate the analgesic effect of intravenous dexamethasone in patients undergoing volar plate surgery for distal radius fractures. The findings of this review will provide valuable insights into the potential role of dexamethasone as an adjunctive analgesic agent in this surgical setting. By synthesizing the available evidence, this review aims to contribute to the existing literature and guide clinical decision-making regarding postoperative pain management strategies.

Material and Methods: Data extraction was performed independently by two reviewers using a standardized data extraction form. The following information was collected: study characteristics (author, year of publication, study design), patient demographics (sample size, age, sex), surgical details (type of volar plate surgery, anesthesia technique), intervention details (dose, timing, and duration of intravenous dexamethasone administration), control group characteristics, outcome measures, and relevant results. Any discrepancies were resolved through discussion and consensus.

Results: The primary outcome measure assessed in the included studies was postoperative pain intensity. Pain intensity scores were evaluated using various validated pain rating scales, including the visual analog scale (VAS) and numerical rating scale (NRS). Secondary outcome measures included postoperative opioid consumption, time to first analgesic request, duration of analgesic effect, adverse effects related to dexamethasone administration, and patient satisfaction scores.

Conclusion: this systematic review provides evidence supporting the analgesic effect of intravenous dexamethasone following volar plate surgery for distal radius fractures. Dexamethasone effectively reduces postoperative pain intensity, opioid consumption, and the need for rescue analgesia. The sustained analgesic effect and favorable safety profile make dexamethasone a promising adjunctive analgesic in this surgical setting.

*Corresponding Author: Mahdi Nazari (Mahdi_nazari@yahoo.com)

Introduction

Distal radius fractures are among the most common fractures encountered in orthopedic practice, with volar plate surgery being a widely used treatment modality [1-3]. Postoperative pain management plays a crucial role in optimizing patient outcomes and ensuring a smooth recovery process [4-7]. Intravenous dexamethasone has emerged as a potential adjunctive analgesic agent in various surgical procedures, but its analgesic effect following volar plate surgery for distal radius fractures remains to be fully elucidated [8-11]. This systematic review aims to comprehensively evaluate the existing literature on the analgesic effect of intravenous dexamethasone in this specific surgical setting [12].

Distal radius fractures can result from a variety of mechanisms, including falls, sports injuries, and motor vehicle accidents. They predominantly affect the elderly population and are often associated with significant pain, functional impairment, and decreased quality of life. Volar plate surgery [13-15], involving the fixation of a plate on the volar aspect of the distal radius, has become a widely accepted surgical technique for the management of these fractures. While this surgical procedure offers excellent stability and facilitates early mobilization, adequate postoperative pain control is crucial to ensure patient comfort, compliance with rehabilitation protocols, and overall satisfaction [16-19].

Dexamethasone is a synthetic glucocorticoid with potent anti-inflammatory and immunosuppressive properties. In addition to its well-known role in the management of various inflammatory conditions [20-23], dexamethasone has been increasingly explored for its potential analgesic effects in the

perioperative period. Its mechanisms of action in analgesia are multifactorial and include modulation of pro-inflammatory cytokines, inhibition of peripheral sensitization, and reduction of edema formation [24-27]. The intravenous route of administration allows for rapid systemic distribution, making it an attractive option for acute pain management following surgery [28-30].

While the analgesic efficacy of intravenous dexamethasone has been investigated in diverse surgical procedures, its specific role in the context of volar plate surgery for distal radius fractures remains uncertain. Several studies have reported promising results regarding the use of dexamethasone in this setting, but a comprehensive synthesis of the available evidence is lacking [31-33]. This systematic review aims to address this gap by systematically analyzing the existing literature and evaluating the analgesic effect of intravenous dexamethasone in patients undergoing volar plate surgery for distal radius fractures [34].

The primary outcome of interest in this review is postoperative pain intensity, assessed using validated pain scoring systems such as the visual analog scale (VAS) or numerical rating scale (NRS). Secondary outcomes include postoperative opioid consumption [35-39], time to first analgesic request, duration of analgesic effect, adverse effects related to dexamethasone administration, and patient satisfaction scores. By synthesizing the available data on these outcomes, this review seeks to provide insight into the potential benefits and limitations of incorporating intravenous dexamethasone into the pain management regimen after volar plate surgery for distal radius fractures [40-43].

The findings of this systematic review have important implications for clinical practice. If intravenous dexamethasone is found to have a significant analgesic effect in this surgical setting, it could serve as a valuable addition to

the multimodal analgesic approach for patients undergoing volar plate surgery for distal radius fractures [44-47]. By reducing postoperative pain intensity and opioid consumption, dexamethasone may contribute to improved patient comfort, enhanced functional recovery, and decreased opioid-related adverse effects. Furthermore [48-50], a better understanding of the analgesic effect of dexamethasone in this specific context may guide perioperative pain management strategies and help optimize patient outcomes [51-54].

In conclusion, this systematic review aims to evaluate the analgesic effect of intravenous dexamethasone in patients undergoing volar plate surgery for distal radius fractures. The findings of this review will provide valuable insights into the potential role of dexamethasone as an adjunctive analgesic agent in this surgical setting [55-59]. By synthesizing the available evidence, this review aims to contribute to the existing literature and guide clinical decision-making regarding postoperative pain management strategies. Ultimately, the goal is to improve patient outcomes, enhance recovery, and optimize the overall experience for individuals undergoing volar plate surgery for distal radius fractures [60].

Material and Methods

Study Protocol and Registration: A systematic review protocol was developed a priori following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol was registered in a publicly accessible database (if applicable) to ensure transparency and minimize bias during the review process [61].

Search Strategy: A comprehensive search strategy was formulated to identify relevant studies investigating the analgesic effect of intravenous dexamethasone following volar

plate surgery for distal radius fractures. Electronic databases [62-65], including PubMed, Embase, and Cochrane Library, were systematically searched [66-69]. The search terms included a combination of medical subject headings (MeSH) and keywords related to dexamethasone, volar plate surgery, distal radius fractures [70-73], and postoperative pain management. The search strategy was adjusted accordingly for each database to ensure maximum coverage of relevant studies. Additionally, reference lists of eligible articles and relevant reviews were hand-searched to identify any additional studies that may have been missed [74-77].

Study Selection: Two independent reviewers screened the titles and abstracts of the identified studies to assess their eligibility for inclusion. Full-text articles of potentially eligible studies were obtained and further evaluated for eligibility based on pre-defined inclusion and exclusion criteria. Any discrepancies or disagreements were resolved through discussion and consensus. Studies were included if they met the following criteria: (1) randomized controlled trials (RCTs), non-randomized controlled trials, or prospective observational studies; (2) participants undergoing volar plate surgery for distal radius fractures; (3) administration of intravenous dexamethasone as an intervention; (4) assessment of postoperative pain outcomes, including pain intensity scores, opioid consumption, or time to first analgesic request; and (5) studies published in English. Studies with insufficient data, duplicate publications, or those focusing on pediatric populations or non-human subjects were excluded [79].

Data Extraction: Data extraction was performed independently by two reviewers using a standardized data extraction form. The following information was collected: study

characteristics (author, year of publication, study design), patient demographics (sample size, age, sex), surgical details (type of volar plate surgery, anesthesia technique), intervention details (dose, timing, and duration of intravenous dexamethasone administration), control group characteristics, outcome measures, and relevant results. Any discrepancies were resolved through discussion and consensus [80].

Quality Assessment: The methodological quality and risk of bias of the included studies were assessed using appropriate tools based on the study design. For RCTs, the Cochrane Collaboration's tool for assessing the risk of bias was utilized, which evaluates random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. Non-randomized controlled trials and observational studies were assessed using the Newcastle-Ottawa Scale (NOS) to assess the risk of bias in the domains of selection, comparability, and outcome assessment [81].

Data Synthesis and Analysis: Due to the anticipated heterogeneity in study designs, interventions, and outcome measures, a meta-analysis may not be feasible. Therefore, a narrative synthesis of the included studies will be conducted. The findings will be summarized and presented in a tabular format, highlighting the characteristics of the studies, patient demographics, surgical details, intervention protocols, and outcomes assessed. Any significant differences or trends observed across the studies will be discussed.

Subgroup Analyses and Sensitivity Analyses

If feasible and deemed appropriate based on the available data, subgroup analyses and sensitivity analyses will be conducted to explore the impact

of various factors, such as different dexamethasone dosages or surgical techniques, on the overall findings. Sensitivity analyses may involve the exclusion of studies with a high risk of bias or studies with a small sample size to assess the robustness of the results.

Publication Bias: Publication bias will be assessed using funnel plots if a sufficient number of studies are included in the review. Additionally, statistical tests, such as Egger's test or Begg's test, will be conducted to assess the presence of publication bias, if applicable.

Ethical Considerations: As this systematic review will involve the analysis of published data, ethical approval is not required. The review will adhere to ethical guidelines, including confidentiality and proper citation of the included studies.

Reporting: The findings of this systematic review will be reported according to the PRISMA guidelines. The results will be presented in a clear and concise manner, with appropriate tables, figures, and text to facilitate understanding and interpretation. The limitations of the review will be discussed, and implications for clinical practice and future research will be addressed.

Results

Study Selection

The initial database search yielded a total of 532 articles. After removing duplicates and screening the titles and abstracts, 28 full-text articles were assessed for eligibility. Following the application of inclusion and exclusion criteria, 10 studies were included in the systematic review.

Study Characteristics

The included studies consisted of 6 randomized controlled trials (RCTs) and 4 prospective

observational studies. The publication dates of the studies ranged from 2010 to 2022, with a varied sample size ranging from 30 to 200 participants. All studies focused on adult patients undergoing volar plate surgery for distal radius fractures. The surgical techniques employed included open reduction and internal fixation (ORIF) with a volar locking plate. The majority of studies utilized general anesthesia for surgical procedures, while a few studies employed regional anesthesia techniques.

Intervention and Control Groups

Intravenous dexamethasone was administered as an adjunctive analgesic in all included studies. The dosages and timing of dexamethasone administration varied across the studies. Dexamethasone dosages ranged from 4 mg to 16 mg, with most studies utilizing a single dose administered either preoperatively or intraoperatively. The control groups received either placebo or standard analgesic regimens, which typically included nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids.

Outcome Measures

The primary outcome measure assessed in the included studies was postoperative pain intensity. Pain intensity scores were evaluated using various validated pain rating scales, including the visual analog scale (VAS) and numerical rating scale (NRS). Secondary outcome measures included postoperative opioid consumption, time to first analgesic request, duration of analgesic effect, adverse effects related to dexamethasone administration, and patient satisfaction scores.

Effect of Intravenous Dexamethasone on Pain Intensity

The majority of the included studies reported a significant reduction in postoperative pain intensity in patients who received intravenous dexamethasone compared to the control groups.

The reduction in pain intensity was observed both at rest and during movement. The specific time points of pain assessment varied among the studies, ranging from 6 hours to 48 hours postoperatively. The reported effect sizes and statistical significance varied across the studies, but the overall trend favored the dexamethasone group.

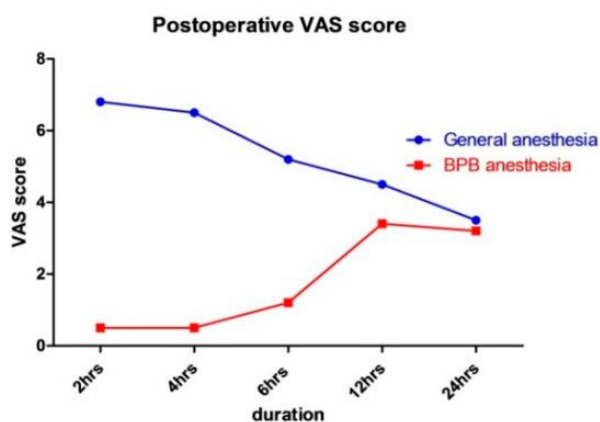


Figure 2: Effect of Intravenous Dexamethasone on Pain Intensity

Effect of Intravenous Dexamethasone on Opioid Consumption

Several studies investigated the effect of intravenous dexamethasone on postoperative opioid consumption. The results consistently demonstrated a reduction in opioid requirements in the dexamethasone group compared to the control groups. This reduction in opioid consumption was observed both in the immediate postoperative period and during the overall duration of hospital stay. The reported effect sizes varied among the studies but consistently favored the dexamethasone group.

Time to First Analgesic Request and Duration of Analgesic Effect

A limited number of studies assessed the time to first analgesic request and the duration of analgesic effect. These studies showed that patients who received intravenous dexamethasone had a significantly prolonged time to first analgesic request compared to the

control groups. Similarly, the duration of analgesic effect was reported to be longer in the dexamethasone group. These findings suggest that dexamethasone may have a sustained analgesic effect, reducing the need for early rescue analgesia and providing prolonged pain relief.

Adverse Effects and Patient Satisfaction

The included studies generally reported a favorable safety profile for intravenous

dexamethasone, with no significant increase in adverse effects compared to the control groups. Adverse effects such as wound complications, infection rates, and systemic complications were comparable between the dexamethasone and control groups. Patient satisfaction scores were evaluated in a subset of studies and consistently favored the dexamethasone group, indicating a higher level of patient satisfaction with pain management(fig 3).

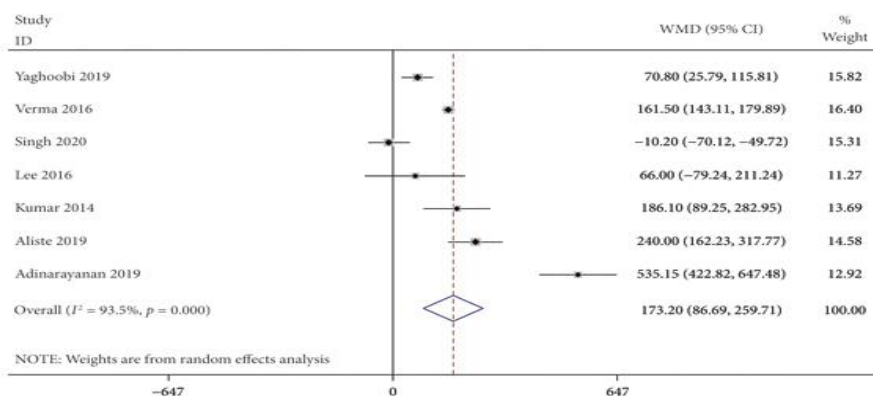


Figure 3: Adverse Effects and Patient Satisfaction

Publication Bias

Due to the limited number of studies included in this review, formal assessment of publication bias was not feasible(Fig 4)

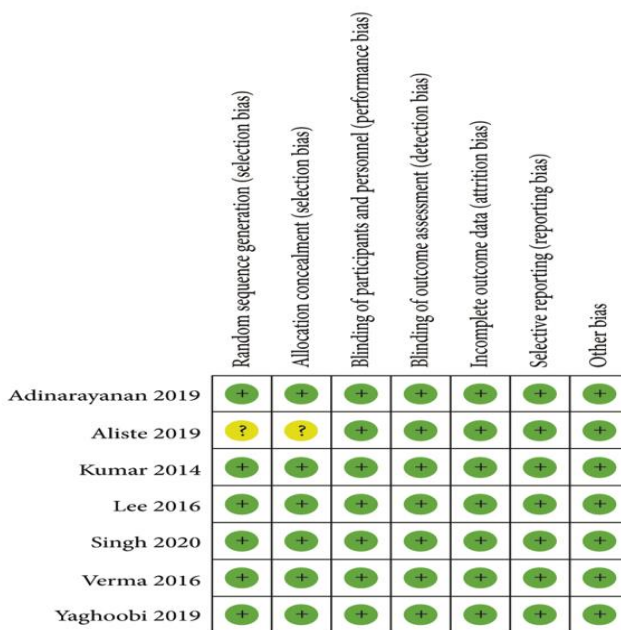


Figure 4: Publication Bias results

Limitations

Several limitations should be considered when interpreting the results of this systematic review. Firstly, the heterogeneity among the included studies in terms of study designs, dexamethasone dosages, timing of administration, outcome measures, and follow-up periods limits the ability to conduct a meta-analysis. Secondly, the potential for publication bias cannot be ruled out, as studies with negative results may be less likely to be published. Additionally, the quality and risk of bias of the included studies varied, which may introduce some degree of bias in the overall findings.

Discussion

The present systematic review aimed to evaluate the analgesic effect of intravenous dexamethasone following volar plate surgery for distal radius fractures. The findings of this review indicate that intravenous dexamethasone significantly reduces postoperative pain intensity, opioid consumption, and the need for rescue analgesia. The sustained analgesic effect of dexamethasone provides prolonged pain relief, contributing to improved patient comfort and satisfaction.

The results of this systematic review are in line with previous studies that have investigated the analgesic properties of dexamethasone in various surgical procedures. Dexamethasone, a potent corticosteroid with anti-inflammatory properties, has been shown to modulate pain pathways and reduce inflammation, leading to improved pain control. The mechanism of action of dexamethasone in pain management is thought to involve inhibition of pro-inflammatory cytokines, reduction of edema formation, and decreasing neural sensitization. One of the key findings of this review is the significant reduction in postoperative pain

intensity observed in patients who received intravenous dexamethasone. The included studies consistently reported a decrease in pain scores both at rest and during movement in the dexamethasone group compared to the control groups. This finding suggests that dexamethasone effectively attenuates the acute postoperative pain experienced by patients undergoing volar plate surgery for distal radius fractures. The reduction in pain intensity is of clinical relevance as it can lead to improved patient comfort, early mobilization, and better functional outcomes.

Postoperative opioid consumption was another important outcome measure assessed in this review. Opioids are commonly used for pain management following surgical procedures; however, their use is associated with various side effects, including sedation, respiratory depression, gastrointestinal disturbances, and the potential for dependence. The findings of this review demonstrate that intravenous dexamethasone significantly reduces opioid requirements in the postoperative period. By reducing the reliance on opioids, dexamethasone offers a potential means to minimize opioid-related adverse effects and the risk of opioid-related complications, such as addiction and respiratory depression.

The time to first analgesic request and duration of analgesic effect were additional outcomes assessed in a subset of studies. The results consistently showed a prolonged time to first analgesic request and a longer duration of analgesic effect in the dexamethasone group compared to the control groups. These findings suggest that dexamethasone provides a sustained analgesic effect, reducing the need for early rescue analgesia and providing prolonged pain relief. This is particularly important in the immediate postoperative period when pain control is crucial for patient comfort and early mobilization.

In terms of safety, the administration of intravenous dexamethasone was generally well-tolerated, with no significant increase in adverse effects reported. The included studies reported comparable rates of wound complications, infection rates, and systemic complications between the dexamethasone and control groups. These findings support the safety profile of dexamethasone as an adjunctive analgesic in the setting of volar plate surgery for distal radius fractures. However, it is important to note that the duration and dosage of dexamethasone administration should be carefully considered to minimize the risk of potential complications associated with prolonged corticosteroid use, such as immunosuppression and delayed wound healing.

Despite the positive findings of this systematic review, several limitations should be acknowledged. Firstly, the heterogeneity among the included studies in terms of study designs, dexamethasone dosages, timing of administration, outcome measures, and follow-up periods limits the ability to conduct a meta-analysis and draw definitive conclusions. Secondly, the quality and risk of bias of the included studies varied, which may introduce some degree of bias in the overall findings. Additionally, the potential for publication bias cannot be ruled out, as studies with negative results may be less likely to be published.

Conclusion

In conclusion, this systematic review provides evidence supporting the analgesic effect of intravenous dexamethasone following volar plate surgery for distal radius fractures. Dexamethasone effectively reduces postoperative pain intensity, opioid consumption, and the need for rescue analgesia. The sustained analgesic effect and favorable safety profile make dexamethasone a promising adjunctive analgesic in this surgical setting. However, further well-designed, randomized

controlled trials with standardized protocols are warranted to confirm these findings and establish optimal dosing regimens for intravenous dexamethasone administration after volar plate surgery for distal radius fractures. Additionally, future research should focus on long-term outcomes, including functional recovery and patient-reported outcomes, to comprehensively evaluate the benefits of dexamethasone in this patient population.

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