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# A Systematic Review of Dexamethasone, Hydrocortisone, and Triamcinolone in the Management of Carpal Tunnel Syndrome

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## Abstract

**Background:** Carpal tunnel syndrome is a common cause of morbidity amongst adults. It is amenable to multiple therapeutic interventions, ranging from splinting to surgical decompression. The decision as to which steroid to use for local injection in carpal tunnel syndrome remains the subject of clinical equipoise. This systematic review provides an up-to-date summary of evidence for steroid injection in carpal tunnel syndrome.

**Methods:** A comprehensive search of Ovid Medline, Ovid Embase, and the Cochrane Central Register of Controlled Trials (CENTRAL) was performed covering from January 1st 1946 to October 12th 2020.

**Results:** Triamcinolone demonstrated efficacy in reducing distal motor latency and pain on VAS. Triamcinolone and dexamethasone demonstrated a significant reduction in distal sensory latency. There was insufficient data available to compare the three steroids to one another.

**Conclusion:** We demonstrate efficacy of triamcinolone and highlight a lack of evidence to make conclusive statements about dexamethasone and hydrocortisone.

**Keywords:** Carpal tunnel; Steroids; Plastic surgery

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## Introduction

Carpal tunnel syndrome (CTS) refers to the symptoms that arise owing to compression of the median nerve as it passes under the flexor retinaculum at the wrist. This compressive neuropathy results in pain, paraesthesia and weakness in the muscles of the hand supplied by the median nerve. CTS is a common disorder that affects 1–5 percent of adults in developed nations [1-3]. It is the most common peripheral nerve entrapment syndrome in adults, representing significant morbidity and cause of reduced productivity [4].

Treatment for carpal tunnel may be broadly classified as surgical and non-surgical. Non-surgical modalities include splinting, physiotherapy, and injection of glucocorticoids. Non-surgical treatments are generally used in mild to moderate CTS, whereas surgical decompression is offered in severe or treatment-resistant manifestations. A 2007 Cochrane systematic review demonstrated glucocorticoid injections provide greater symptomatic relief than placebo; however, the symptomatic relief was transient [5]. This widely used, minimally invasive technique provides rapid symptom relief and may be repeated if symptoms recur.

Different glucocorticoid injections are used for the treatment of CTS. Owing to a limited number of studies directly comparing glucocorticoids, with significant variation in study design, quality and population characteristics, it is unknown which steroid is the safest and most efficacious. This systematic review provides an up-to-date review of the literature comparing the outcomes from different glucocorticoid injections.

## Research Methodology

This study was conducted according to the methodology described in the Cochrane Handbook for Systematic Reviews of Interventions [6], and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The study was prospectively registered on the International Prospective Register of Systematic Reviews (PROSPERO). CRD42020202792.

 

## Search and screening strategy

A comprehensive search of Ovid Medline, Ovid Embase, and the Cochrane Central Register of Controlled Trials (CENTRAL) was performed covering from January 1st 1946 to October 12th 2020. The search strategy can be found in **Table 1.** The title, abstract, and full text screening was performed by two reviewers (XMZ and EBD) independently and in duplicate using piloted screening forms. Disagreements during screening moved onto the next stage for further in-depth review. Discrepancies between reviewers were discussed with the senior author (PM) and the principal investigator (JM).

## Inclusion and exclusion criteria

Included studies were primary studies in the English language with usable data looking at adult patients with CTS involving one or both hands in the absence of peripheral neurological conditions, treated using primary corticosteroid injection with dexamethasone, hydrocortisone, or triamcinolone. Studies that were in another language, non-human subjects, reviews, case reports, commentaries, editorials, and conference abstracts were excluded. In studies that used the same population, the study with the larger patient pool was used. For studies that looked at different doses of the same steroid, the population group receiving the higher dosage was used.

## Data extraction

A predefined form was used by each independent reviewer to extract data from the selected studies. This included title, authorship, number of patients for each study, mean age, and follow-up period. Outcome measures for pre and post intervention periods were extracted. These included clinical severity scores: DASH, PRWE, GSS, pain, and grip strength, and neurophysiology measures including mean motor latency and mean sensory latency.

## Statistical analysis

Kappa score was used to assess agreement between the reviewers during the study screening. Based on the guidelines of Landis and Koch, a κ of 0 to 0.2 represents slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, and 0.61–0.80 substantial agreement [7]. A value above 0.80 is considered near perfect agreement. The paired student *t*-test was used to compare pre- and post-injection outcomes for each individual steroid, and outcomes between steroids were compared using the unpaired student *t*-test. $P < 0.05$ was considered to be statistically significant

**Table 1** Search strategy and number of results on Ovid Medline, Embase, and CENTRAL.

| Search number | Search term | Ovid Medline and Embase | CENTRAL |
|---|---|---|---|
| 1 | Carpal tunnel | 29243 | 1527 |
| 2 | Carpal tunnel syndrome | 27525 | 1458 |
| 3 | Dexamethasone | 239312 | 11887 |
| 4 | Hydrocortisone | 215634 | 9484 |
| 5 | Triamcinolone | 41979 | 3245 |
| 6 | 1 or 2 | 29243 | 1568 |
| 7 | 3 or 4 or 5 | 462019 | 23596 |
| 8 | 6 and 7 | 457 | 89 |
| 9 | Remove duplicates from 8 | 375 | - |

# Results

## Study selection

The initial search of online databases yielded 457 titles from Ovid Medline and Ovid Embase and 89 titles from CENTRAL. After deduplication, this resulted in a total of 404 studies that underwent screening. Using pre-determined criteria to screen titles, abstracts, and full texts, a total of 24 eligible studies were used in this systematic review. Six of these studies did not have any relevant or usable data, and were subsequently excluded, for a total of 20 studies [8-25]. A summary of the studies and treatment modalities examined can be found in **Table 2.** Literature search and screening results can be found in **Figure 1.**

Agreement on study inclusion between reviewers for title was moderate (κ: 0.593 SE: 0.070), for abstract was near perfect (κ: 0.837 SE: 0.078), and for full text was near perfect (κ: 0.902 SE: 0.096).

## Distal motor latency

Two studies with 37 patients reported distal motor latency (DML) at latest follow-up for dexamethasone, which had a mean value of 4.35 ms [17,20]. Two studies with 33 patients reported DML at latest follow-up for hydrocortisone, which had a mean value of 4.2 ms [15,23]. Finally, 14 studies with 344 patients receiving triamcinolone reported a mean DML value of 4.57 ms [8-10,12-16,18,19,21-25] **(Table 3).**

A comparison of pre and post injection mean DMLs reveals that patients receiving triamcinolone had a statistically significant reduction in DML at the latest follow-up, mean difference (MD) -0.56 (95% CI: -0.33:-0.78, p=0.0001). No statistically significant difference was found for dexamethasone or hydrocortisone.

There was no statistically significant difference between the three different steroids **(Table 4).**

## Distal Sensory Latency

Two studies with 37 patients reported distal sensory latency (DSL) at the latest follow-up for dexamethasone, which had a mean value of 4.00 ms [17,20]. Only one study reported DSL for hydrocortisone [15]. Eight studies with 186 patients reported DSL for patients receiving triamcinolone and had a mean value of 3.88ms at the latest follow-up [9,12-14,16,21,22,25].

A comparison of pre and post injection mean DSLs found that patients receiving triamcinolone experienced a statistically significant reduction in DSL, MD: -0.55 (95% CI -0.36:-0.75, *p*=0.002). Patients receiving dexamethasone also experienced a significant reduction in DSL post injection, MD: -0.29 (95% CI -0.16:-0.42, *p*=0.022).

There was no statistically significant difference between

**Table 2** Summary of studies included in this review.

| Study | Treatment, number of patients and mean age | | | Length of follow-up | Study design |
|---|---|---|---|---|---|
| | D | H | T | | |
| Hsu et al. | - | - | 28 (57.1) | 12 weeks | RCT – double blinded |
| Karimzadeh et al. | - | - | 20 (54.8) | 12 weeks | RCT – double blinded |
| Wu et al. | - | - | 27 (54.3) | 6 months | RCT – double blinded |
| Dilokhuttakarn et al | 30 (48.7) | - | 30 (49.3) | 8 weeks | RCT – double blinded |
| Raeissadat et al. | - | - | 41 (51) | 6 months | RCT |
| Bahrami et al. | - | - | 32 (51.7) | 10 weeks | RCT – double blinded |
| Lee JY et al. | - | - | 15 (50.3) | 12 weeks | RCT |
| Soltani et al. | - | 17 (46.7) | - | 8 weeks | RCT |
| Seok et al. | - | - | 16 (49.7) | 3 months | RCT |
| Deniz et al. | 17 (46) | - | | 8 weeks | Prospective cohort |
| Karadas et al. | - | - | 20 (46.4) | 6 months | RCT |
| Karadas et al. | - | - | 34 (48) | 6 months | RCT – double blinded |
| Moghtaderi et al. | 20 (30) | - | - | 3 weeks | Prospective cohort |
| Lee JH et al. | - | - | 14 (52) | 8 weeks | Prospective cohort |
| Dewi et al. | - | - | 25 (53.6) | 4 weeks | RCT |
| O'Gradaigh | - | 16 | 18 | 6 weeks | RCT |
| Giannini et al. | - | - | 31 (55.2) | 6 months | Prospective cohort |
| Rayegani et al. | - | - | 23 (54) | 10 weeks | RCT |

D = Dexamethasone, H = Hydrocortisone, T = Triamcinolone

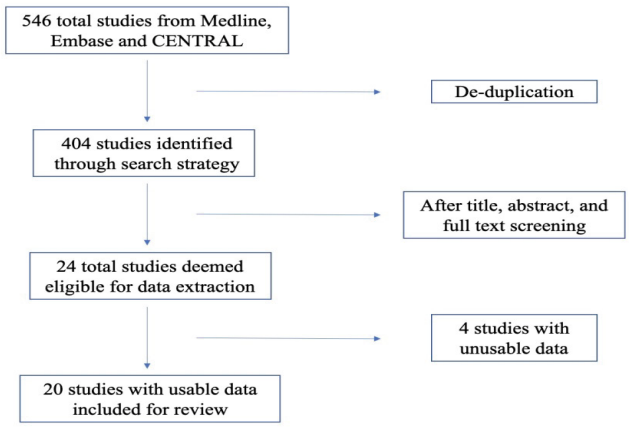


**Figure 1** Schematic of search, screening and data extraction results.

An improvement in DSL post-procedure was observed with both dexamethasone and triamcinolone, with mean reductions of 0.29 ms and 0.55 ms, respectively. This statistically significant improvement was determined in a cohort of only 37 patients receiving dexamethasone. The studies for hydrocortisone were underpowered to demonstrate significance.

**Table 3** Summary of mean DML, DSL, and VAS for included studies at latest follow-up.

| Study | Mean DML (ms) | | | Mean DSL (ms) | | | VAS | | |
|---|---|---|---|---|---|---|---|---|---|
| | D | H | T | D | H | T | D | H | T |
| Hsu et al. | - | - | 4.89 | - | - | - | - | - | 3 |
| Karimzadeh et al. | - | - | 4 | - | - | 4 | - | - | 3.7 |
| Wu et al. | - | - | 5 | - | - | - | - | - | 4.5 |
| Dilokhuttakarn et al | - | - | - | - | - | - | - | - | - |
| Raeissadat et al. | - | - | 3.9 | - | - | 3.5 | - | - | 2.7 |
| Bahrami et al. | - | - | 4.04 | - | - | 3.94 | - | - | 2.3 |
| Lee JY et al. | - | - | 4.68 | - | - | 4.08 | - | - | - |
| Soltani et al. | - | 4 | - | - | 3.8 | - | - | 2.5 | - |
| Seok et al. | - | - | 4.37 | - | - | 3.28 | - | - | 3.31 |
| Deniz et al. | 4 | - | - | 3.8 | - | - | - | - | - |
| Karadas et al. | - | - | 4.76 | - | - | - | - | - | 4.76 |
| Karadas et al. | - | - | 4.9 | - | - | - | - | - | 4.9 |
| Moghtaderi et al. | 4.7 | - | - | 4.2 | - | - | 4.3 | - | - |
| Lee JH et al. | - | - | 4.8 | - | - | 4.7 | - | - | 1.4 |
| Dewi et al. | - | - | 5.42 | - | - | 3.39 | - | - | - |
| O'Gradaigh | - | 4.4 | - | - | - | - | - | - | - |
| Giannini et al. | - | - | 4.3 | - | - | - | - | - | - |
| Rayegani et al. | - | - | 4.32 | - | - | 4.12 | - | - | 3.04 |

D = Dexamethasone, H = Hydrocortisone, T = Triamcinolone, DML = Distal Motor Latency, DSL = Distal Sensory Latency, VAS = Visual Analogue Scale

dexamethasone and triamcinolone, MD: 0.123 (95% CI -0.625:0.872, p=0.718). No analysis on hydrocortisone could be done owing to insufficient data **(Table 5).**

## Pain

Only one study reported pain as measured by the visual analogue scale (VAS) for dexamethasone and hydrocortisone in 20 and 17 patients, respectively [15,20]. Ten studies with 255 patients reported VAS for patients receiving triamcinolone. No analysis between different steroid groups could be done owing to insufficient data for dexamethasone and hydrocortisone groups [8-10,12,13,16,18,19,21,25]. Patients receiving triamcinolone showed a significant reduction in pain post injection, MD: -2.48 (95% CI -1.64:-3.31, *p*=0.0001).

# Discussion

We provide an up-to-date summary of studies comparing different steroid formulations for treatment of CTS. Using 20 available papers, we have directly compared three corticosteroids: dexamethasone, triamcinolone, and hydrocortisone with regards to specific outcomes. Grip strength and functional scores were not analysed owing to insufficient data.

Of the three steroid injections reviewed, only triamcinolone demonstrated efficacy at reducing DML. This was with an average reduction of 0.56 ms in the 344 patients observed. It is important to note that only 37 and 33 patients for dexamethasone and hydrocortisone cohorts respectively were available for analysis. To accurately ascertain whether hydrocortisone and dexamethasone truly reduce DML, further studies need to be performed.

**Table 4** Mean DML, DSL, and VAS pre and post injection, and comparison of pre and post injection using paired t-test.

| Steroid Used | Distal motor latency (ms) | | Paired t-test result | Distal sensory latency (ms) | | Paired t-test result | Pain on VAS | | Paired t-test result |
|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | | Pre | Post | | Pre | Post | |
| Dexamethasone | 4.68 | 4.35 | MD: 0.33<br>CI: -1.32 – 1.98<br>p = 0.239 | 4.29 | 4 | MD: 0.29<br>CI: 0.163 – 0.417<br>p = 0.022 | 8.7 | 4.3 | - |
| Hydrocortisone | 4.5 | 4.2 | MD: 0.30<br>CI: -2.24 – 2.84<br>p = 0.374 | 4.3 | 3.8 | - | 6 | 2.5 | - |
| Triamcinolone | 5.13 | 4.57 | MD: 0.56<br>CI: 0.33 – 0.78<br>p = 0.0001 | 4.43 | 3.88 | MD: 0.55<br>CI: 0.359 – 0.75<br>p = 0.002 | 5.84 | 3.37 | MD: 2.48<br>CI: 1.64. – 3.31<br>p = 0.0001 |

VAS = Visual Analogue Scale

**Table 5** Comparison of post injection DML, DSL and VAS of dexamethasone, hydrocortisone, and triamcinolone against each other using the unpaired t-test.

| Variables | Distal motor latency | Distal sensory latency | Pain on VAS |
|---|---|---|---|
| D vs. H | MD: 0.150<br>CI: -1.58 – 1.88<br>p = 0.7455 | - | - |
| D vs. T | MD: -0.22<br>CI: -0.932 – 0.492<br>p = 0.518 | MD: 0.123<br>CI: -0.625 – 0.872<br>p = 0.718 | - |
| H vs. T | MD: -0.37<br>CI: -1.059 – 0.319<br>p = 0.269 | - | - |

The only corticosteroid with sufficient data to demonstrate an improvement in post-procedural pain was triamcinolone, with a reduction of 2.48 on the 10-point VAS. This clinically significant reduction in pain establishes triamcinolone as an excellent therapeutic option in the management of CTS. Unfortunately, there is insufficient data to make inferences of the effectiveness of hydrocortisone and dexamethasone at improving CTS pain. Larger studies of hydrocortisone and dexamethasone reporting pain on a 10-point VAS need to be performed.

While minor adverse effects including transient pain were described [8,12], none of the studies reported significant adverse outcomes related to glucocorticoid injection. Within wider literature, major complications such as intraneural injection of glucocorticoids have been reported [26]; however, there is currently insufficient evidence to comment on the comparative safety of the different glucocorticoids for CTS.

## Conclusion

Patients receiving triamcinolone can expect an improvement in DMS and DSL and pain. Data was lacking to report on dexamethasone and hydrocortisone. Owing to paucity of comparative studies, it was not possible to compare dexamethasone, hydrocortisone and triamcinolone to one another.

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## Statement of Human and Animal Rights

Human studies included in this article contain no identifiable information. This article does not contain any studies with animal subjects.

## Statement of Informed Consent

No patient identifiable information is present in this systematic review and as such, no consent was required for its production.

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