



Research article

Combined distal median nerve block and local anesthesia with lidocaine:epinephrine for carpal tunnel release

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ABSTRACT

Aim: Evaluating patient comfort during full awake local anesthesia in carpal tunnel release surgery, without tourniquet use, by using epinephrine to obtain a completely dry surgical field.**Methods:** We included into the study 41 patients who underwent carpal tunnel syndrome surgery under full awake combined anesthesia, using a 9-point questionnaire. Pain and anxiety in all patients were evaluated through a Wang-Baker 0–5 scale. The injection solution consisted of 0.1cc of epinephrine and 10cc of 1% lidocaine (1:100.000); 5cc were used for local cutaneous anesthesia, and 5cc were used for distal median nerve block. All patients underwent a classic, open carpal tunnel release.**Results:** Anxiety scores during anesthesia and the post-operative period did not show a statistically significant difference ($p > 0.01$), with keeping their levels at low perception scores (average score of 1.68 ± 0.38 CI 95%, with a modal value of 2, compared to an average of 0.78 ± 0.29 CI 95% with a modal value of 0). Similar results were obtained for pain scores during anesthesia (1.73 ± 0.48 CI 95% with a most frequent modal score of 1). Our results also showed that the effects of combined anesthesia in carpal tunnel release surgery persisted well into the 6-hour post-operative moment, pain scores remaining low, statistically significant similar to recorded values during the anesthesia moment ($p > 0.01$), at an average of 2.29 ± 0.5 CI 95% with a modal value of 1. No serious complications were recorded.**Conclusion:** Combined distal median nerve block and local anesthesia with epinephrine:lidocaine provides a comfortable option for patients, with minimal risks of complications.

1. Introduction

Carpal tunnel syndrome remains one of the most common conditions presented to orthopedists, plastic surgeons and rheumatologists, causing disabilities and affecting quality of life [1]. The pathology represents 90% of the total neuropathies of the median nerve [2].

Carpal tunnel release is a surgical procedure performed usually as out-patient surgery by using local anesthesia. For this and other procedures, hand surgeons prefer a bloodless surgical field [3]. In this sense, Braithwaite et al reported the efficiency of using a pneumatic tourniquet to control bleeding in hand surgery with local anesthesia [4].

The ideal anesthesia method is simple, efficient, safe and swift in restoring full sensibility and functional use to the affected hand [5]. A key factor influencing the procedure is the chosen method of anesthesia. There are several reports about what type of anesthesia can be used and

wide-awake local anesthesia has gained popularity for many surgical procedures in the recent years. Plastic surgeons make no exception and local infiltration of lidocaine and epinephrine is preferred for many short time procedures [4, 6]. Still, there is no consensus regarding the best anesthetic method for carpal tunnel release, or even surgical management, being it open or endoscopic carpal tunnel release [7].

Wide-awake local anesthesia, according to a survey of the American Society for Surgery of the Hand, was performed in only 8% of cases in the United States, while 43% were managed with monitored anesthesia care [8, 9]. On the other hand, subcutaneous local anesthesia is employed more often in Canada [10] and surgeons in Brazil prefer intravenous regional anesthesia [11].

In studies comparing wide-awake local anesthesia with no tourniquet use with regional anesthesia, patients preferred in overwhelming percent the wide-awake local anesthesia over regional anesthesia [7].

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The main focus in such studies was patient comfort, assessed through the quantification of pain levels during the anesthetic method employed and surgical act.

However, anxiety is also correlated with pain and patient comfort and can influence perceived pain [12], but previous studies regarding wide-awake local anesthesia in carpal tunnel release did not address this parameter, let alone during each step of the surgical procedure.

Therefore we present our approach of combined distal median nerve block and local anesthesia for carpal tunnel decompression with multimodal anesthesia in carpal release surgery, for obtaining a dry surgical field, without the need of tourniquet use, with a focus on an assessing patient comfort, by evaluating pain and anxiety scores through each of the anesthetic and surgical steps of the procedure, before, during and after surgery.

2. Materials and methods

This is a controlled case series study that was approved by the local Ethics Committee - Emergency County Hospital Cluj-Napoca - and the study protocol conformed to the ethical guidelines of the 2008 Declaration of Helsinki. All patients provided written informed consent after receiving appropriate study information. Over a period of one and a half years (2017–2019), 41 patients were included in the study.

2.1. Patient selection

The established inclusion criteria were patients between 18 and 70 years of age diagnosed with symptomatic carpal tunnel syndrome, including paresthesia in at least two fingers in the territory of the median nerve, with positive clinical Phalen and reversed Phalen tests that were unresponsive to non-surgical treatment. Exclusion criteria consisted of any other neurological pathology that caused similar symptomatology, mental disorders that could provide a bias in our evaluation (i.e. anxiety disorders), the presence of an algoneurodystrophic syndrome, anticoagulated patients, the presence of forearm arteriovenous fistula for dialysis, tenosynovitis, patients with diabetes mellitus and other polyneuropathies.

2.2. Treatment protocol

All patients were scheduled to undergo the procedure in an outpatient setting. Before starting any procedures, an informed consent form was completed by the patients. All patients included in the study were thoroughly informed with regard to the anesthesia and the procedures we wished to follow, and all agreed to participate in our study and signed the consent statement.

2.3. Anesthesia

We prepared the anesthetic solution using 0.1 cc of epinephrine to 10 cc of lidocaine (1:100.000 epinephrine:lidocaine). Teguments were aseptitized with Betadine solution. Using a 10 ml syringe in which we aspirated the anesthetic solution and attached a 23G needle, we performed a distal median nerve block and local anesthesia on the planned incision line. Anatomically, the median nerve at the level of the radio-carpal region is situated between the palmaris longus and flexor carpi radialis tendons [13]. The needle was inserted perpendicular at the proximal transvers crease and the solution was slowly injected. After injecting 5cc of solution for the median nerve block, the needle was retracted up to the subdermal plane and further solution was injected for the palmar branch of the median nerve. The rest of the anesthetic solution was injected as local anesthesia on the line of the planned incision [14]. A total of 10cc of local anesthesia were used for this combined anesthesia. The surgery was performed 20 min after injecting the anesthetic solution (Figure 1) [15].



Figure 1. 20 minutes after local anesthesia with good vasoconstriction effect. Note the pale aspect of the skin.

2.4. Surgical procedure

The procedure started with a longitudinal incision deep to the retinaculum flexorum until the carpal ligament was reached; the ligament was opened to reveal the median nerve. A proximal and distal fasciotomy was performed with scissors, avoiding the recurrent thenar branch and superficial branch for the palmar arch of the median [16]. Lavage with 0.9% saline solution was performed and the wound was closed in a horizontal mattress fashion with non-absorbable monofilament 4:0 sutures.

The patients remained under observation for an hour postoperatively prior to discharge, and each was given a questionnaire to be completed (Supplementary Material 1). Patients filled out the questionnaires at home after discharge, during the same day for the points 1–5 and 8. The points 6–7 and 9 in the patient questionnaire were filled out during the 2 week post-operative recovery time, until sutures were removed.

Patients were followed-up at one and two weeks post-surgery.

2.5. Data and statistics

Based on the inclusion criteria described above, 41 patient records with 20 attributes were collected. Data was structured into patients' personal information, completion of the Wang-Baker questionnaire, surgical context, and medication. Data was collected in Microsoft Excel 2016 spreadsheets.

The purpose of the statistical analysis is to follow the evolution of the perception of pain and anxiety from the pre-surgery, during anesthesia and surgery, to the post-surgery moment (at 3 and 6 h). Additionally, it

aims to demonstrate a constant low score of pain and anxiety over the monitoring period. On the other hand, the relation between anxiety and pain was explored. For these purposes, descriptive statistics, inferential comparison and correlation tests were performed.

In addition to a sample descriptive summary, the average scores with their CI 95% and the most frequent modal values were calculated over the monitoring period. However, as anxiety and pain are scored through subjective assessment relying on the Wang-Baker scale (0 = no perception to 5 = high perception), nonparametric tests are used to compare pain and anxiety groups over monitoring stages. Means and variation are calculated just for descriptive reasons for the comparison part of the analysis.

For overall comparison of scores between stages (both for pain and anxiety), the nonparametric repeated measures Friedman rank sum test was used, followed by Wilcoxon signed-ranks post-hoc testing to assess pair comparisons. To evaluate the relationship between anxiety and pain, Spearman's ranks correlation tau was used, as well as a Pearson liner model to assess the fit of pain-anxiety datapoints. The level of statistical significance alpha was set to 0.01.

Statistical analysis was performed in R software, version 4.0.3.

3. Results

Sample description: Due to the specific of our surgical unit, the observed yearly rate of carpal tunnel syndrome is on average around 7%, (between 33 to 36 patients per year out of a total of around 500 patients per year). The inflow of patients into the surgical unit during the period of the study (2017–2019) was 1,009 patients, out of which 74 presented carpal tunnel syndrome. This corresponds to the blended rate of 7.33% for carpal tunnel syndrome. With these 74 patients with carpal tunnel syndrome as the basis of selection, for a 4% maximum margin of error and 95% confidence level, we calculated a sample of 41 subjects needed for a reliable sample. The selection was randomized with respect to male/female and age.

The average age of patients was 53.6 ± 10.3 years. Despite the fact that the gender split is inclined significantly towards female patients (75.6%) compared to male patients (24.4%), the sample is balanced with regards to age between genders (53.1 ± 11.7 in men and 53.8 ± 10 in women). The same applies to the affected hand (right hand 22, left hand 19 patients).

Pain and anxiety descriptive statistics are shown in Table 1.

Of the 41 patients evaluated after the procedure, 95.12% declared that they would choose this type of anesthesia if they had to undergo this surgery again. Only 4.88% patients would choose analgo-sedation and general anesthesia. Both these patients reported high anxiety levels before the procedure and increased pain during anesthesia administration. Pain and anxiety trends are shown in Figure 2.

Overall comparison between pain scores in the different questioned time intervals revealed a statistically significant difference ($p < 0.01$,

Friedman chi-squared = 48.962). Post-hoc comparison test found no significant statistical difference in pain scores between anesthesia and three hours post-operative stages ($p = 0.164$) between anesthesia and six hours post-operative stages ($p = 0.022$, a result at the threshold of statistical significance, taking into account the chosen level of significance 0.01), but there was a significant lower perception in pain at the three hour moment, compared to the six hour post-operative moment ($p = 0.0003$). The pain score during anesthesia was found to be significantly higher than that perceived during the operative period ($p < 0.01$, Wilcoxon $V = 300$). Both pain at three hours ($p < 0.01$) and at six hours post-operative ($p < 0.01$) were significantly higher than pain intra-operative.

Regarding anxiety scores, Friedman overall comparison between the different moments of monitoring showed statistically significant differences ($p < 0.01$, Friedman chi-squared = 26.42). Post-hoc paired comparisons revealed no statistical difference between intraoperative and post-operative anxiety levels. Pre-operative anxiety was greater than intra-operative ($p = 0.0003$) and post-operative anxiety ($p < 0.01$). No statistically significant results regarding anxiety levels between intra-operative compared to post-operative scores were shown ($p = 0.01537$, but this result is at the threshold of the chosen statistical level of significance).

Correlation between anxiety and pain over the monitored period is shown in Figures 3, 4, and 5.

During anesthesia, pain-anxiety data points are spread along the scale, with a few upbound outliers. Higher pain is associated to higher anxiety, but also low pain to low anxiety.

There is a significant, moderate correlation between pain and anxiety ($\rho = 0.5321$, $p = 0.00034$). The linear model fit shows a moderate correlation ($R = 0.5297$, $p = 0.00036$).

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During operatory, pain-anxiety data points tend to cluster on the middle-lower half of the anxiety-pain scale. There is a significant, stronger correlation between pain and anxiety ($\rho = 0.6541$, $p < 0.0001$). The linear model fit shows also a stronger correlation between pain and anxiety at this stage ($R = 0.6875$, $p < 0.0001$).

Post-operative, pain-anesthesia data points tend to cluster on the lower half of the scale.

There is a significant, moderate correlation between pain and anxiety ($\rho = 0.4886$, $p = 0.0011$).

The linear model fit shows also a moderate correlation between pain and anxiety at this stage ($R = 0.4445$, $p = 0.003$).

Three (7.31%) patients reported postoperative nausea but only one (2.43%) patient had post-operative vomiting.

We encountered one (2.43%) patient with wound dehiscence. The patient did not need a revision suture. The wound was kept clean and disinfected until closure was achieved.

During surgery, four (9.75%) patients required additional hemostasis, performed with a bipolar.

4. Discussion

The main goal of carpal tunnel release surgery is to have good decompression of the median nerve with minimum intra-operative complications and less postoperative pain. Over time, several types of anesthesia have been used for carpal tunnel release: general anesthesia, regional anesthesia (brachial plexus block, Bier block) and local anesthesia [17, 18].

General anesthesia is very rarely used for this procedure nowadays, because of the serious complications that can occur (deep vein thrombosis, pulmonary embolism, myocardial infarction and cardiac arrest) [19]. Regional anesthesia is often used in hand surgery, but there are also risks of severe complications, such as pneumothorax, neurological damage, cardiovascular problems, compartment syndrome [20, 21, 22, 23]. Moreover, intravenous regional anesthesia shortens the procedure

Table 1. Pain and anxiety assessment.

Parameters	Average	Min	Max
Pain during anesthesia*	1.73	0	5
Pain during surgery*	0.48	0	3
Pain 3 h after surgery*	1.34	0	5
Pain 6 h after surgery*	2.29	0	5
Preoperative anxiety**	1.68	0	5
Intraoperative anxiety**	1.12	0	4
Postoperative anxiety**	0.78	0	3

* Wong–Baker Pain Scale rating, with numbers from 0 to 5, where 0 means lack of pain and 5 means the worst pain imaginable [6].

** Levels measured on a visual numeric scale from 0 (no anxiety) to 5 (highest level).

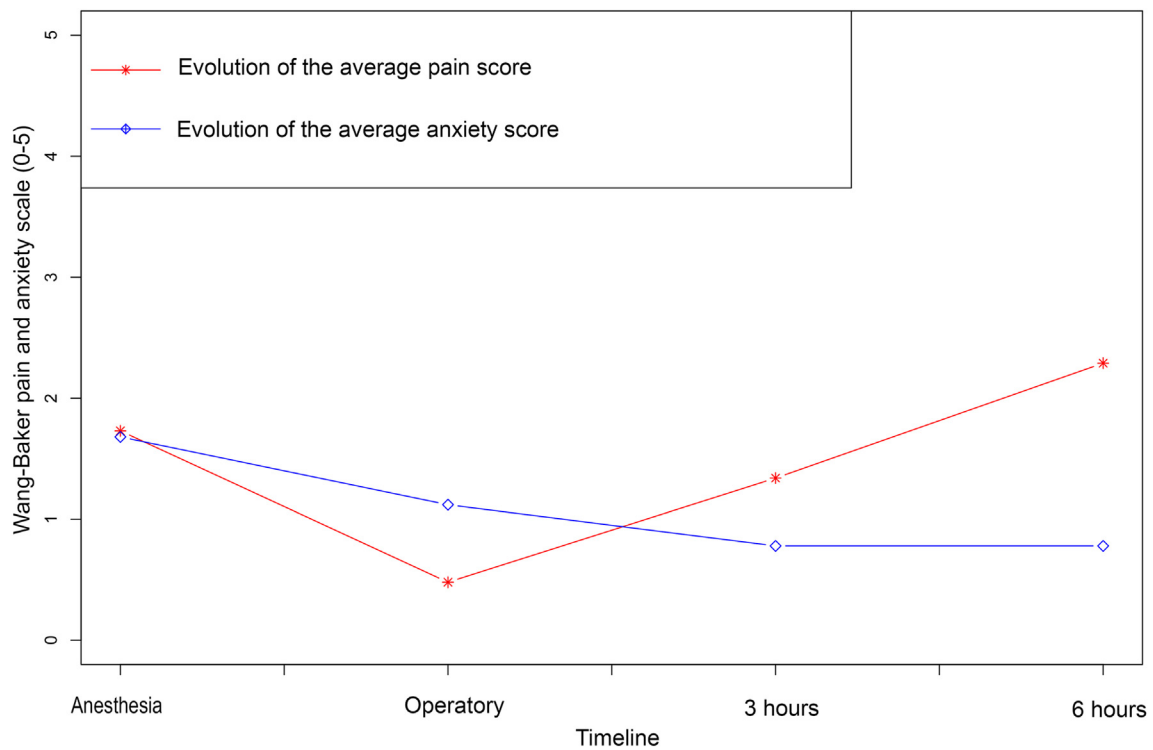


Figure 2. Joint trend of pain and anxiety over the monitoring period.

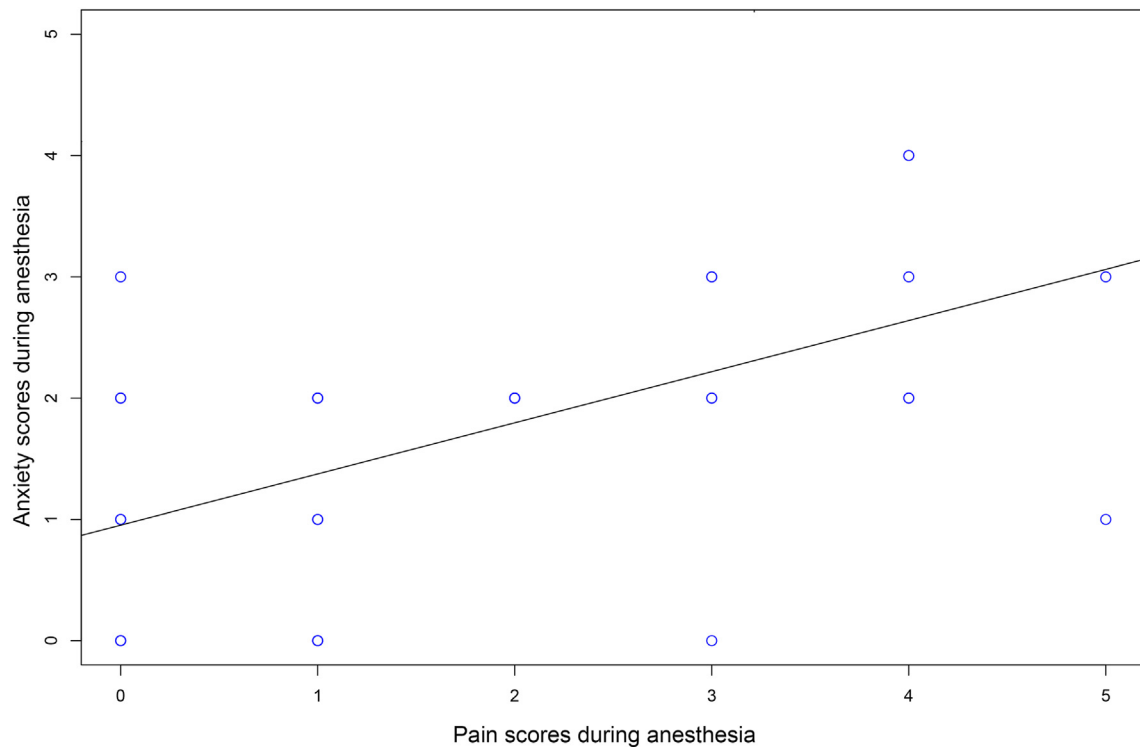


Figure 3. Correlation and Linear Model fit between anxiety and pain during anesthesia. Pain proves to be a significant predictor of anxiety, the linear model shows: $\text{anxiety} \sim \text{pain} + \text{intercept}$; $p = [0.0003, 0.0004]$, $R^2 = 0.28$.

time because of tourniquet-related pain. The minimal tourniquet time to prevent systemic toxicity of local anesthesia is 30 min and this can prolong the operation room time [24]. Tomaino et al found no statistically significant differences between local and regional anesthesia regarding pain and anxiety levels measured by Visual Analog Scale (VAS) [25].

There are several papers comparing wide-awake local anesthesia with no tourniquet use with regional anesthesia, reporting no significant differences in patient comfort and pain levels during the anesthetic method employed or at the intra-surgical site or even during the entire procedure, but only in the studies where sedation was also employed for both

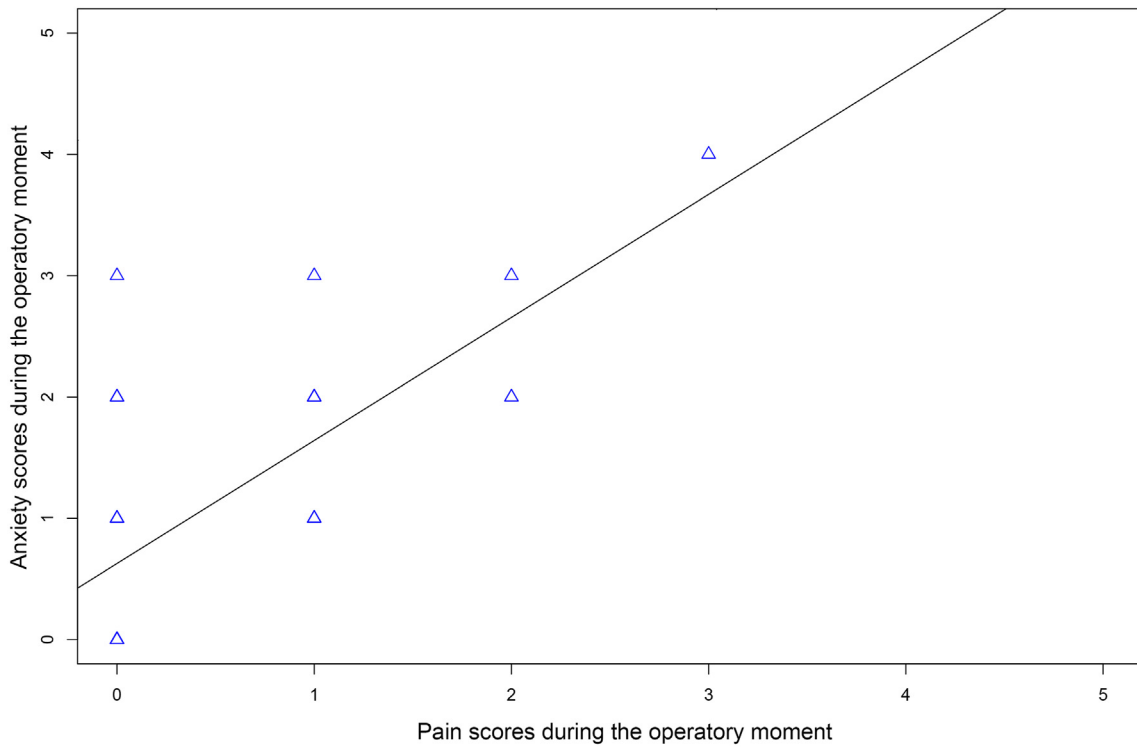


Figure 4. Correlation and Linear Model fit between anxiety and pain during the operatory moment. Pain proves to be a stronger significant predictor for anxiety, the linear model shows: $\text{anxiety} \sim \text{pain} + \text{intercept}$; $p = [<<0.0001, 0.0001]$, $R^2 = 0.47$.

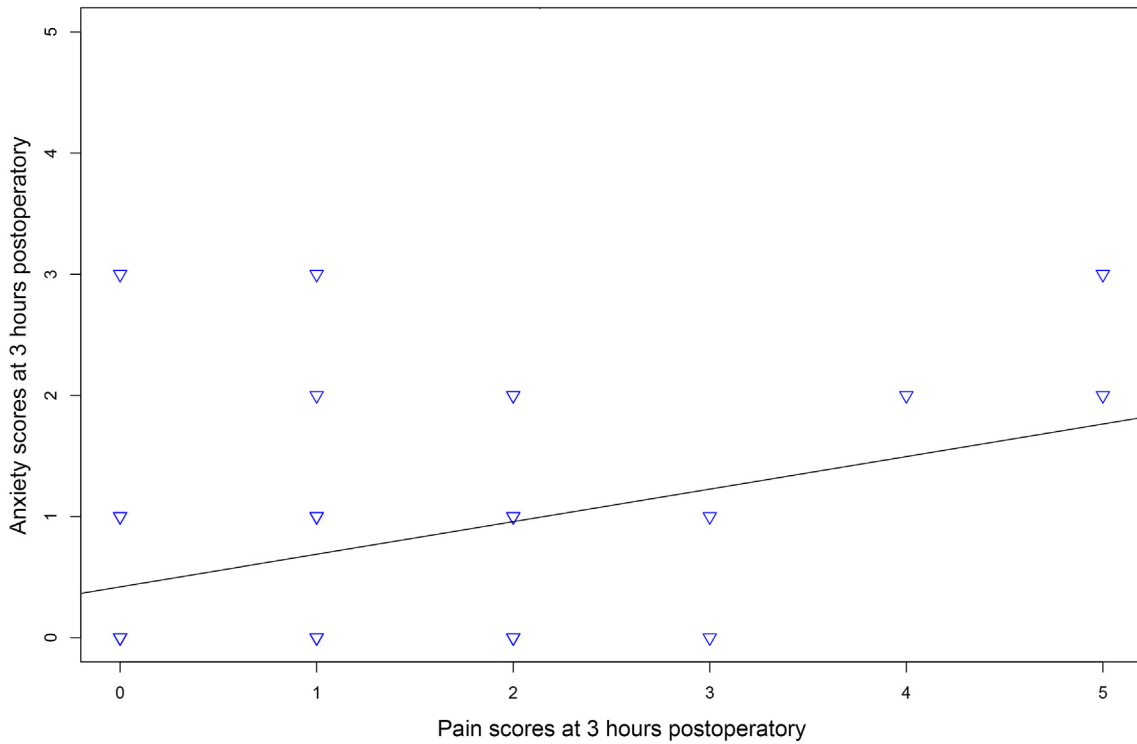


Figure 5. Correlation and Linear Model fit between anxiety and pain at 3 h post-operative. Pain proves to be a moderate, significant predictor for anxiety, the linear model shows: $\text{anxiety} \sim \text{pain}$; $p = 0.003$, $R^2 = 0.19$.

methods. However, in comparative studies were no sedation as used, significant pain level differences were predominantly attributed to the use of tourniquet during the surgical procedure and patients preferred the wide-awake local anesthesia over regional anesthesia [7, 25, 26]. These

findings are in accordance with the results in the present study, our patients reporting low pain and anxiety scores during all steps of the surgical management of open carpal tunnel release.

Some studies also focused on the economic advantages of local anesthesia compared to monitored anesthesia care and the differences, as expected, are impactful, with local anesthesia being far more cost-effective than regional or general anesthesia and cost differentials of up to \$1613 being reported [7, 27].

Regarding local anesthesia, lidocaine is safely injected but there are few studies with the combination of lidocaine:epinephrine (1:100.000) for median nerve block. It is known that adding epinephrine to the anesthetic solution has two effects: it prolongs the duration of the anesthetic and it causes local vasoconstriction and hemostasis [28].

Thomson et al showed the safe use of epinephrine in hand surgery [29]. However, there is still a reluctance of using epinephrine around nerves, illustrated even in anesthetic textbooks and English literature reports [30, 31]. But this established “dogma” is challenged by extensive clinical use and recent reviews of literature that underline the safety of epinephrine as a potentiator of lidocaine in peripheral nerve blocks [32, 33].

Braithwaite et al demonstrated the safe use of lidocaine with epinephrine for local anesthesia and also demonstrated its efficiency in pain control in comparison with the use of tourniquet [4].

There are a few reports of local anesthesia used in carpal tunnel release surgery, even some using the combined epinephrine and lidocaine anesthesia. Tomaino et al used the technique described by Altissimi and Mancini (1998), by injecting 5cc of 1% lidocaine into the carpal canal and 5cc at the line of incision. They reported no need for additional intra-operative use of anesthesia and no local complications (nerve damage, local infection) [34]. These observations are in accordance with the results in our study. We found this type of multimodal anesthesia to be safe with almost all patients having no post-operative complications at the 2 week post-operative follow-up.

We also found that the combined technique of median nerve block and local anesthesia with epinephrine showed satisfactory results with prolonged pain-free time, from the preparatory time, during surgery, and up to 3–6 h post-surgery, compared to the local anesthesia reported by the other authors [24, 34, 35]. This is due to the prolonged effect of lidocaine by the local reduced blood flow from the vasoconstrictor epinephrine (a temporary and reversible process).

Tzarnas et al performed a study on carpal tunnel release without a tourniquet and obtained a dry surgical field with the vasoconstrictive effect of epinephrine in local anesthesia. Their study included anesthesia on 21 wrists of 17 patients which they followed-up for an average of 24 months. Results showed that all patients had a dry surgical field and tourniquet was never required. Comparing this to our study, we were able to highlight that the combination of epinephrine:lidocaine in median nerve block and local anesthesia offers a similar dry field and prolonged anesthetic effect, which was not evaluated by Tzarnas [3].

Myers et al described the result of epinephrine use in nerve block and the nerve blood flow effect (NBF). Results showed that there is a significant laser Doppler measurement reduction and the association with 1% lidocaine would aggravate this effect. This was an animal model study. However, in our study, we found that this type of anesthesia was safe [31].

Another unique feature of this study is the evaluation of pain levels of patients at the immediate post-operative time (at three and six hours). While pain scores remained at an average low during all questioned time moments, the combined effect of epinephrine:lidocaine anesthesia persisted towards the six-hour post-operative moment, increasing the comfort of patients in the post-operative time.

There was also a statistically significant correlation between pain and anxiety at all the monitored moments and pain and anxiety scores shifted from scores all across the scale (0–5) in the pre-operative moment to much lower scores by the 6 h post-operative moment.

In conclusion, combined distal median nerve block and local anesthesia with epinephrine:lidocaine provides a comfortable option for patients and is associated with low pain and anxiety scores intra- and post-operatively and a dry surgical field. It is easy to use in an outpatient clinic

and shortens the patient's stay in hospital after surgery, with minimal complications.

Declarations

Author contribution statement

Yusef Sallum, Lucian Fodor and George-Ioan Mărginean: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Florian Bodog: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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