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Comparative Study - Hematoma Block and Hematoma Block Plus Interosseous Nerve Block for Distal Radius Fractures Closed Reduction

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ABSTRACT

Introduction: Distal radius fractures (DRF) are among the most frequent acute injuries in an Orthopaedics Emergency Department (OED). If displaced, these fractures need reduction. During closed reduction, pain usually prevents patients from collaborating appropriately. In our experience, even after a hematoma block (HB), patients still report pain during the reduction manoeuvre. The interosseous nerves terminal branches (APIN) innervate the distal radioulnar joint, the wrist capsule, the carpal bones and the intrinsic ligaments. The addition of the APIN block can be an option to lower the pain during and after the reduction manoeuvre.
Materials and methods: This is an IRB approved consecutive case series study of acute DRF initially handled in the OED of our hospital. Pain during and after the reduction manoeuvre was evaluated by the Visual Analogue Scale (VAS). We used lidocaine at 2% as a local anaesthetic and performed a hematoma block (HB) with 10mL 2% lidocaine or HB plus APIN block (HBIN) with 15mL 2% lidocaine, in an alternate series.
Results: We included 52 cases with mean age of 60 years. Twenty-four patients with HB and 28 with HBIN. The mean VAS score during the reduction manoeuvre in group HB was 3.8 (SD 2.1; range 0 to 8); the mean VAS score in the HBIN group was 1.6 (SD 1.3; range 0 to 5).
Conclusion: Adding the APIN block to the HB proved more effective than the HB alone in the reduction of the pain during the reduction and can be a good tool when dealing with DRF in the OED. A larger randomised trial is recommended to confirm these study results.

Keywords:
distal radius fracture, closed reduction, posterior interosseous nerve, hematoma block, wrist innervation

INTRODUCTION

Distal radius fractures are among the most frequent acute injuries in an Orthopaedics Emergency Department (OED). They can represent approximately 18% of fractures in the elderly, and in Europe this incidence varies from 35 to 105 fractures per 10,000 inhabitants per year. This number may progressively increase due to Europe's aging population[1-3].

If displaced, these fractures need reduction and in the majority of cases may be treated conservatively if this is obtained[3], but there are still issues about the possibility of multiple attempts to reduce the fracture, the chosen reduction manoeuvre and many other concerns the attending surgeon must take care of[4]. One of the most common issues is how to deal with the pain during the closed reduction manoeuvre and the type of anaesthesia to be applied, because the intense pain usually prevents patients from collaborating appropriately and can make the reduction more difficult.

Many authors have addressed the hematoma block, associated or not with general or intravenous anaesthesia[1]. In our experience, even after a hematoma block (HB), patients still report moderate to severe pain during the reduction manoeuvre. Jimenez *et al*[1] described another option to reduce the pain during the reduction manoeuvre. These authors separated two groups of patients: one to receive only a hematoma block and the other to receive the hematoma block plus a median nerve block and a radial nerve sensory branch block. Despite their good results, the disadvantage of their technique in our point of view is the addition of multiple site injections to the patient.

We devised a different approach: to perform the HB plus an anterior and posterior interosseous nerve block (HBIN). We use the same entrance point to perform the HB and the

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interosseous nerve block, therefore avoiding another injection site pain or discomfort. Also, there is less pain and morbidity to the median nerve, which can be compromised in severely displaced distal radius fractures; thus, the injection of the local anaesthetic inside the carpal tunnel could increase the pressure over the median nerve. The addition of the radial nerve block in our point of view would not be useful, because we didn't use finger straps to perform the reduction manoeuvre.

The anterior and posterior interosseous nerves (APIN) innervate the distal radioulnar joint, the wrist capsule, the carpal bones and the intrinsic ligaments[5]. The anterior interosseous nerve is the longest branch of the median nerve. It runs downward on the interosseous membrane between the flexor pollicis longus and the flexor digitorum profundus muscles ending under the pronator quadratus, supplying this muscle and the distal radioulnar, radiocarpal and carpal joints. The posterior interosseous nerve is a branch of the radial nerve. It passes deep into the extensor pollicis longus muscle and descends on the interosseous membrane to the dorsum of the wrist. It ends in a small nodule that sends branches to the distal radioulnar, radiocarpal, and carpal bones, joints and ligaments[6].

Therefore, the addition of the APIN block to the HB may be an option to lower the pain during and after the reduction manoeuvre.

The objective of this study is to compare the efficacy of the hematoma block alone to the addition of the anterior and posterior interosseous nerve block during the closed reduction manoeuvre of displaced distal radius fractures.

MATERIALS AND METHODS

This is a prospective, non-randomised, comparative case series study of acute displaced distal radius fractures initially handled in the OED of our hospital. This work was approved by the hospital's Institutional Review Board and all patients signed an informed consent.

All patients with a diagnosed displaced distal radius fracture assessed in the OED were invited to participate in this study. Only those who accepted to take part in it were then sequentially separated into two groups, being the odd-numbered patients treated with HB as an anaesthetic method and the even-numbered patients treated with HBIN block as an anaesthetic method. We used Frykman's radiologic classification[7] for all fractures. This was used only to stratify our cohort of distal radius fractures.

For those patients who accepted to take part in this study, the inclusion criteria were closed acute displaced distal radius fractures, requiring closed reduction and immobilisation in patients at a minimum of 18 years of age. The exclusion criteria were open fractures, pathological fractures, local signs of infection and neurological disease with cognitive impairment that could prevent the patient's collaboration with the treatment.

Pain during the reduction manoeuvre was evaluated by the Visual Analogue Scale (VAS), using a direct question from the patient. All patients were asked about the VAS score during and right after the reduction manoeuvre.

The authors used lidocaine at 2% as a local anaesthetic, because it is a commonly found local anaesthetic agent in our OED. We performed the hematoma block (HB) with 10 mL 2% lidocaine and the HBIN with 15mL 2% lidocaine (10mL to the hematoma and 5mL to the interosseous nerves), as described below. A 21G needle (0.8mm x 40mm) was used to inject the solution.

In the HB group, the fracture line was identified by palpating the distal fragment. The needle was inserted at around 1cm proximal to the fracture line and the hematoma was infiltrated with a solution of 10mL of 2% lidocaine, taking into account the application of a completely aseptic procedure. The needle was inserted into the fracture site at a 30° angle from proximal to distal. Correct insertion of the needle was confirmed by aspiration of the fracture hematoma.

In the HBIN group, the hematoma block was performed as described above, using the same amount of 2% lidocaine. Using the same point of entrance to perform the HB, the needle was redirected into a 90° angle perpendicular to the radius and then towards the interosseous space between the radius and the ulna. The needle was gently directed over the radius until it fell into the soft space between the two bones. A total of 3mL of the solution was injected over the interosseous membrane and after that the needle progressed until it penetrated the membrane. Then, 2mL of the solution was injected. This way, the blockade of the terminal branches of both the posterior and the anterior interosseous nerves was achieved with only one point of entrance.

The time for closed reduction was set to 10 minutes after the blockade. Lidocaine's pharmacokinetics has been studied in a variety of clinical models, which include healthy volunteers, subjects with chronic pain syndromes, and patients with cardiac failure. The speed of onset of lidocaine is 1 to 5 min after local infiltration, and 5 to 15 min after peripheral nerve blockade[8]. Therefore, the 10-minute wait till the reduction manoeuvre was thought to be appropriate for the onset of a good anaesthetic effect. If a patient still felt intense pain during the manoeuvre, we waited a further 5 minutes.

We applied a common technique for the reduction of distal radius fractures. The author performed all the blockades and supervised all procedures, and the reduction manoeuvre was performed by the author or orthopaedic resident doctors under the direct supervision of the author. Then, a short arm cast was applied, leaving the fingers and the thumb free. After reduction, all patients performed a control radiograph in order to evaluate if the reduction was satisfactory or not. We used the ASSH criteria for a satisfactory reduction in control radiographs, such as radial shortening below 3mm, dorsal tilt below 10°, and intra-articular displacement or step-off below 2mm[9].

All patients were then separated into four subgroups: HB with or without satisfactory reduction, and HBIN with or without satisfactory reduction, according to the above criteria. In cases that a non-satisfactory reduction was obtained, the patient was informed about other treatment possibilities.

All patients were then followed up according to our department normatives, with control appointments and control radiographs at two and four weeks. If there was a loss reduction, the patient was offered surgical intervention. If the reduction was maintained, the patients were followed up until healing. All patients were followed up until one year after the fracture.

Epidemiological data collected were: patients' gender and age, fracture pattern according to Frykman's classification, Visual Analog Scale score for pain (VAS; from 0 to 10) during the reduction of the fracture, reduction success and complications.

RESULTS

From February to September 2023, a total of 52 patients were included in our cohort. There were 42 female patients, accounting for 81% of the cases. Age at the time of the fracture varied from 26 to 94 years, with 60 years as the mean value (Fig. 1).

The complete cohort of patients is described below, in Table I, according to the age intervals, gender distribution and incidence of cases. We noted a higher incidence of fractures among females in the age interval between 61 and 80 years old, accounting for 69% of cases in the feminine group.

Fig. 2 displays our patients per type of anaesthesia. The HB group consisted of 24 patients and the HBIN group of 28 patients (4 patients initially included in the HB group were lost to follow-up, because they were related to workers' compensation).

Frykman's classification for all cases is displayed in Table II. In this table, we further separated the number of cases according to each group. We noted that Frykman's types 1 and 2 were the most common cases, representing 34% of the cases, followed by types 3 and 7, representing 30% of the cases. We noted the less common pattern of fracture was Frykman's type 6, in only 6% of our patients.

The mean VAS score during the reduction manoeuvre in group HB was 3.8 (ranging from 0 to 8); the mean VAS score in the HBIN group was 1.6 (ranging from 0 to 5). Table III displays our initial analysis. In the HBIN group, only two of the 28 patients (8% of the HBIN group) reported a higher score of pain (one at level 4 and one at level 5) and 54% of the patients referred pain intensity at zero or 1. On the other hand, in our HB group, 13 of the 24 patients (54% of the HB group) informed pain at level 4 or over and only 12% of the patients referred to pain intensity at level zero or 1. The distribution of the perceived pain scores is displayed in Fig. 3. Table IV displays all patients according to pain score and percentages.

One can see that the majority of patients had a lower score of pain in the HBIN group in comparison to the HB group. In Table III, we can observe the complete distribution of the intensity of the pain score and how many of the patients there were with each grade of pain.

We also analysed the achievement of a satisfactory reduction in both groups and within each group. We were able to achieve an initial satisfactory reduction in 41 of the 52 cases (79%) regardless of the anaesthetic technique employed, as shown in Fig. 4.

When we separated the patients into groups, there was a percentage difference between both. Data are described in Table V below. The reduction was considered satisfactory in 21 of the 28 cases in the HBIN group (75%) and in 20 of the 24 patients in the HB group (83%).

The next step was to analyse if the intensity of pain during the reduction manoeuvre could be a causative factor to provide a non-satisfactory reduction. In Table VI, we can see that in cases where the intensity of pain was higher, there were more unsatisfactory results. We noted an unsatisfactory reduction in 40% of patients with a score of pain at 4 and 33% of patients with a score of pain at 5 in a total group analysis per grade of intensity of pain. Probably, in our group of patients, the intensity of pain may have interfered with the reduction manoeuvre and prevented us from achieving a satisfactory reduction in these patients. The four patients without a satisfactory reduction and with a pain score of 4 and 5 belonged to the HB Group (Table VII). There is no concordance between our groups in terms of intensity of pain and satisfactory or unsatisfactory reduction, because we noted only two patients with a high score of pain in the HBIN group.

Table I: Case Statistics of patients according to gender and age intervals.

Age	Gender and Relative Percentage			
	Masculine	M %	Feminine	F %
18 – 39	0	0%	2	5%
40 – 50	4	40%	0	0%
51 – 60	1	10%	5	12%
61 – 70	0	0%	15	36%
71 – 80	2	20%	14	33%
81 – 90	2	20%	5	12%
> 91	1	10%	1	2%
Total Cases	10	100%	42	100%

Table II: Frykman's Classification (Types).

Frykman's Classification (Types)	I	II	III	IV	V	VI	VII	VIII	Total
Total number of cases	9	9	8	5	4	3	8	6	52
HB 4	5	4	2	2	1	2	4	24	
HBIN	5	4	4	3	2	2	6	2	28
Percentage of cases	17%	17%	15%	10%	8%	6%	15%	12%	100%

Table III: Visual Analogic Score for pain perceived during the reduction manoeuvre.

Perception of Pain	HBIN Group	HB Group
Medium VAS Score	1,6	3,75
Standard Deviation	1,3	2,1
Maximum pain perceived	5	8
Minimum pain perceived	0	0
Median of values	1	4

Table IV: Intensity of pain during reduction according to the anaesthetic technique.

Intensity of pain	HBIN Group	Percentage number of patients	HB Group number of patients	Percentage
0	5	18%	1	4%
1	10	36%	2	8%
2	7	25%	5	21%
3	4	14%	3	13%
4	1	4%	4	17%
5	1	4%	5	21%
6			1	4%
7			2	8%
8			1	4%
Total Number of Cases	28	100,00%	24	100,00%

Table V: Satisfactory reduction per group.

	Satisfactory	%	Non-satisfactory	%
HBIN Group	21	75%	7	25%
HB Group	20	83%	4	17%

Since we had more patients in the low intensity of pain range, this could be the reason why we had more cases of unsatisfactory reduction even without a high level of pain.

DISCUSSION

Distal radius fractures represent approximately one-sixth of all fractures treated in an orthopaedic emergency department (OED). There are three peaks of incidence of this type of fracture, according to the age of the patients. The first one is in children between 5 and 14 years old, the second one is in adult males under 50 years old and the third one is in females above 40 years old[10]. In our study, we included only adult patients, so the first group of high incidences was excluded from our analysis.

Table VI: Quality of the reduction / total group.

Pain Intensity	Satisfactory (n=41)	Unsatisfactory (n=11)	Total Cases	% Satisfactory	% Unsatisfactory
0	5	1	6	83%	17%
1	9	3	12	75%	25%
2	10	2	12	83%	17%
3	6	1	7	86%	14%
4	3	2	5	60%	40%
5	4	2	6	67%	33%
6	1	0	1	100%	0%
7	2	0	2	100%	0%
8	1	0	1	100%	0%
Total	41	11	52		

Table VII: Quality of reduction per group.

Intensity of pain	HBIN Group	Quality of Reduction		HB Group	Quality of Reduction	
		Satisfactory	Unsatisfactory		Satisfactory	Unsatisfactory
0	5	4	1	1	1	0
1	10	7	3	2	2	0
2	7	5	2	5	5	0
3	4	3	1	3	3	0
4	1	1	0	4	2	2
5	1	1	0	5	3	2
6				1	1	0
7				2	2	0
8				1	1	0
Total Patients	28	21	7	24	20	4

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0	5	1	6	83%	17%
1	9	3	12	75%	25%
2	10	2	12	83%	17%
3	6	1	7	86%	14%
4	3	2	5	60%	40%
5	4	2	6	67%	33%
6	1	0	1	100%	0%
7	2	0	2	100%	0%
8	1	0	1	100%	0%
Total	41	11	52		

Table VII: Quality of reduction per group.

Intensity of pain	HBIN Group	Quality of Reduction		HB Group	Quality of Reduction	
		Satisfactory	Unsatisfactory		Satisfactory	Unsatisfactory
0	5	4	1	1	1	0
1	10	7	3	2	2	0
2	7	5	2	5	5	0
3	4	3	1	3	3	0
4	1	1	0	4	2	2
5	1	1	0	5	3	2
6				1	1	0
7				2	2	0
8				1	1	0
Total Patients	28	21	7	24	20	4

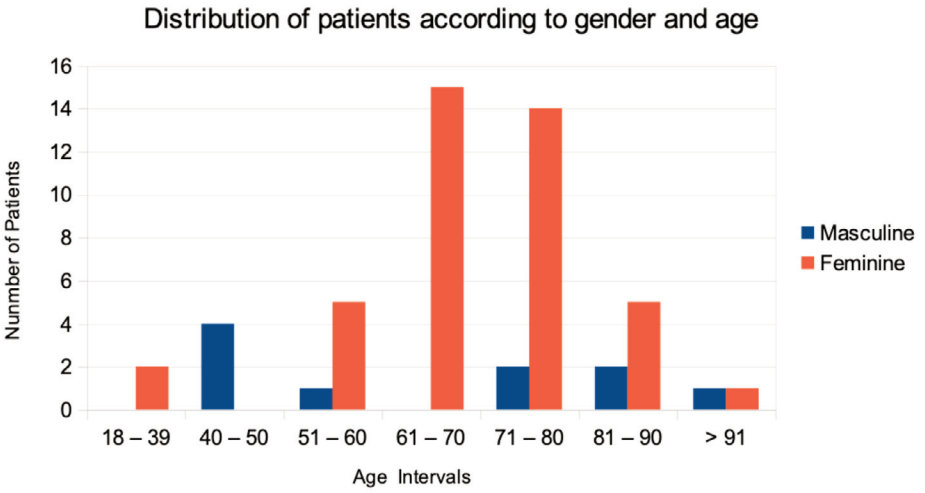


Fig. 1: Distribution of patients according to gender and age intervals.

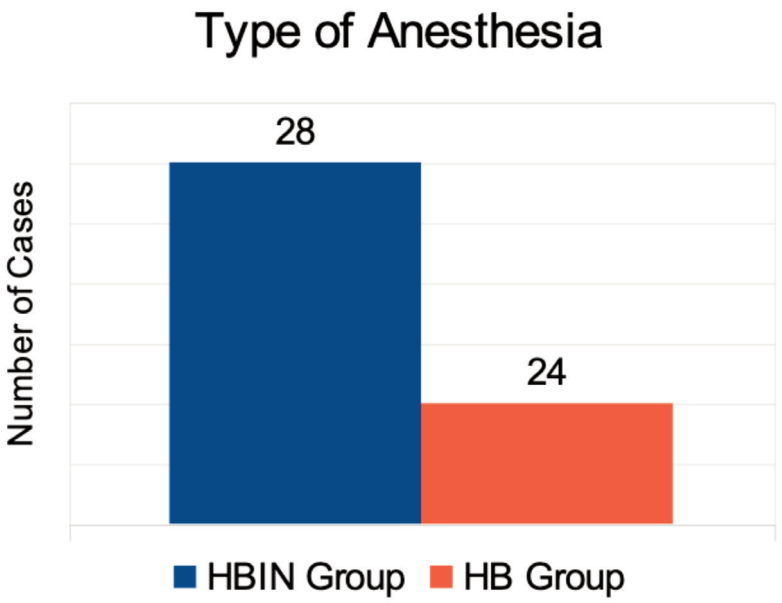
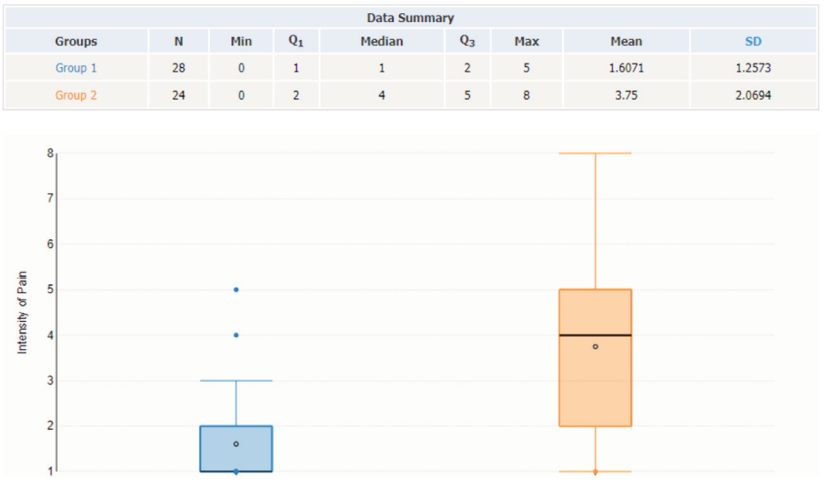


Fig. 2: Number of cases per type of anaesthesia.



Data Summary

Groups	N	Min	Q_1	Median	Q_3	Max	Mean	SD
Group 1	28	0	1	1	2	5	1.6071	1.2573
Group 2	24	0	2	4	5	8	3.75	2.0694

Fig. 3: Box-plot displays statistical data related to both groups. In this specific graphic, Group 1 (in blue) is the HBIN Group of patients; Group 2 (in orange) is the HB Group.

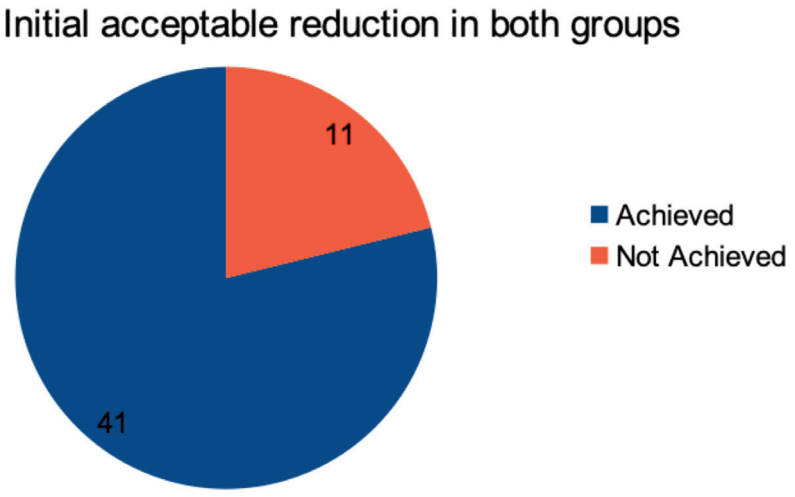


Fig. 4: Number of patients where an initial satisfactory reduction was achieved.

In the adult males' group, we observed a higher incidence in the age interval from 40 to 50 years old (40% of the fractures in males). This is in accordance with the majority of the literature[1,10]. In the adult females' group, we observed a higher incidence in the age intervals ranging from 61 to 80 years old (36% in the interval 61-70 and 33% in the interval 71-80). We agree with Ruch[10] that these may represent two different injuries: one related to high-energy trauma in younger men and the other to an insufficiency fracture in older females.

We used the classification of Frykman[7] to evaluate our patients because it is simple and has a higher interobserver and intra-observer performance. Frykman established a classification that incorporated individual involvement of the radiocarpal and radioulnar joints[7,10]. Sharma *et al*[11] assessed the reliability and reproducibility of AO/OTA, Frykman and Fernandez classification systems for distal radius fractures on computed tomography. They concluded that the Frykman and AO/OTA classification systems performed better than the Fernandez classification system in terms of interobserver reliability and the Frykman classification system performed better than both AO/OTA and Fernandez classification systems in terms of intra-observer reproducibility.

According to Ruch, in order to achieve a satisfactory reduction of a displaced distal radius fracture, it is necessary a successful pain relief and to overcome muscle spasm. The hematoma block with supplemental sedation or the Bier block may provide good anaesthesia in many settings[10], but they depend on the presence of additional staff or to take the patient to the operating room.

There are many reports in the literature about the positive effect of peripheral nerve blocks associated with the hematoma block (HB) in the reduction of distal radius fractures. Jimenez *et al*[1] included 192 patients in their study to evaluate if the level of pain during the closed reduction manoeuvre of distal radius fractures using HB plus the radial sensory nerve (RSN) and the median nerve (MN) block was lower than using an isolated HB and whether they were equally effective. They concluded that HB plus RSN and MN block was more effective than HB alone in reducing the pain during wrist fracture reduction, especially for finger pain. Since they used strapping to the fingers to perform the reduction manoeuvre, their best results were related to finger pain. In our group of patients, we applied traction to the fingers and counter-traction along the forearm and elbow, and so we didn't apply extra pressure on the fingers. In their study, they had to add two more injections to block the RSN and the MN. The advantage of our technique, besides more effect on lowering the pain levels, was that we applied only one injection.

Cela-López *et al*[12] conducted a prospective cohort study with two groups, hematoma block (HB) and hematoma with associated median nerve block (MHB). They evaluated 140 fractures and performed the same technique of closed reduction as Jimenez *et al*[1], with finger straps attached to the patients' fingers. In their study, the most painful area during fracture reduction in the HB group was finger traction in 78% of cases, while in the MHB group there was the manipulation of the fracture site in 71% of cases. They concluded that the association of median nerve block was useful for decreasing pain perception during the closed reduction manoeuvre, when compared to HB alone. But they also had to have two sites of injection.

Many other authors[13-16] discussed different anaesthetic techniques for the reduction of distal radius fractures. The most common alternatives are the HB, Bier block, general anaesthesia, and brachial plexus block. The application of

local anaesthesia is fast and efficient in reducing the perceived pain during the reduction manoeuvre of these fractures. To our knowledge, our study is the first to compare HB to HB plus the anterior and posterior interosseous nerve block (HBIN) in anaesthesia for the reduction of distal radius fractures. Our results show that the addition of anterior and posterior interosseous nerve blocks provided an excellent effect during the manoeuvre of reduction of distal radius fractures, and we could avoid the discomfort of applying other injections to an already painful wrist.

Another point of view is the evaluation of the quality of the reduction and the type of anaesthesia. Alatishe *et al*[17] compared the radiographic quality of initial reduction of distal radius fractures reduced using hematoma block (HB) to those reduced with intravenous sedation (IS). In their study, 67 patients completed the trial with 33 patients in the HB group and 34 patients in the IS group. They noted no significant difference in the radiographic quality of initial reduction between the two groups using the Sarmiento's modification of Lindström criteria, but 5 out of 34 patients among the sedated group had gastrointestinal symptoms. Koren *et al*[18] noted that IS seemed to be more efficient than hematoma block alone in supporting closed reduction of distal radius fractures in the OED. But there is the concern that this method needs specialised personnel, and more time spent on the OED. In our study, analysing both groups of HB and HBIN, we observed 79% of good results regarding the obtention of a satisfactory reduction, without the gastrointestinal side effects and the longer time of stay at the OED these authors found. We've noted there were more unsatisfactory reductions when there were higher pain levels (see Table VI and Table VII). The reduction quality was more unsatisfactory in the HB group, in our opinion related to a higher intensity of pain during the reduction manoeuvre.

In our study, we observed that the association of the anterior and posterior interosseous nerve blocks had a positive effect in decreasing pain intensity during the manipulation of distal radius fractures. In the majority of our HBIN patients, the higher level of pain was lower than in the group of hematoma block alone patients.

The data from our work support the use of the hematoma block plus an anterior and posterior interosseous nerve block at the wrist instead of only the hematoma block technique to decrease the patients' perceived pain during the manipulation of the wrist to perform a closed reduction of a distal radius fracture. The HBIN technique resulted in a greater reduction in mean VAS score for pain during the reduction manoeuvre compared with the isolated HB technique and had the same success in achieving a satisfactory reduction without complications.

Our study has limitations because we've studied a small number of patients, and we didn't use sample size calculations for this pilot study. A new study with a larger number of patients will be able to give us more statistical power. Other limitations include: a non-randomised design, a possible operator bias because all blocks were performed by the same surgeon and being a single centre study. As this was, to our knowledge, the first paper to describe this technique, we believe that it can be reproduced and applied to a larger number of patients and there is a possibility of performing blinded research, in which neither the patient nor the attending surgeon knows which type of block is applied (HBIN or HB). This way, the evaluation of the block's effect on pain reduction can be better understood.

CONCLUSION

The addition of the anterior and posterior interossous nerves block to the hematoma block proved to be more effective than the hematoma block alone in the reduction of the perceived pain during the reduction manoeuvre in acute displaced distal radius fractures and can be a very good option when dealing with distal radius fractures patients in the OED. The author acknowledges that a larger randomised trial may be recommended to confirm these study results.

CONFLICT OF INTEREST

The authors declare that there are no potential conflicts of interest.

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