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The long-term effectiveness of ultrasound guided cervical medial branch radiofrequency ablation in treatment of chronic neck pain of zygapophysial joints origin

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Abstract
Background: The cervical facet joints, which are the fourth most frequent source of years spent disabled globally, are a major contributor to chronic neck pain. Additionally, it is the main cause of pain for 26% to 70% of those with chronic neck pain. Therefore, the purpose of this study was to assess the efficiency of the ultrasound guidance in radiofrequency ablation of cervical medial branch in cases of chronic neck pain with facetogenic origin.
Methods: Thirty individuals with chronic neck pain from facet origin participated in this prospective, randomised trial, for three or more months in Tanta university hospital from July 2021 to July 2022. Our procedures were conducted in two steps: firstly, performing Cervical Medial Branch Block. Secondly, only patients with ≥ 80% alleviation of symptoms via dual MBBs were included for the radiofrequency neurotomy of cervical medial branch.
Results: Our results showed significant reduction of pain index, improvement in Neck Disability index score and also improvement of patients' satisfaction in all times of measurements and follow up.
Conclusions: Chronic neck pain resulting from zygapophysial joints origin may be effectively and safely treated by ultrasound-guided cervical medial branch radiofrequency ablation.

Keywords: Ultrasound guided, radiofrequency, ablation, zygapophysial joints

Introduction

Cervical medial branch radiofrequency ablation (CMBRFA) has been shown to be an effective treatment for cervical zygapophyseal discomfort. It has been confirmed by many prospective observational studies and high-quality trials with randomized controls. In these studies, the procedure eliminated their pain for 60-70% of the chosen individuals for an average of approximately nine months [1-4].

Thermal radiation is used in radiofrequency neurotomy of the cervical medial branch to coagulate the sensory nerves, which disrupts the nociceptive input signal from the painful zygapophyseal joint(s) [5].

According to the Spine Interventional Society (SIS), the selection of patients for CMBRFA should be based on their ability to completely resolve their symptoms after diagnostic dual medial branch blocks (MBBs) ± a placebo control block [6]. Although the dual MBB ± placebo block selection criterion with 100% symptom enhancement lowers the false positive rates, this protocol is time-consuming, expensive, and does not meet the SIS-recommended standard for choosing lumbar medial branch radiofrequency (LMBRFA) ablation. It may prevent some patients from receiving an effective treatment. Nowadays, 80% enhancement of symptoms with dual concordant MBBs [6] is the SIS recommendation for (LMBRFA), which is recognized to provide great results [7]. Due to these factors, concordant dual cervical MBBs are frequently utilized in practice to achieve 80% symptom relief [5].

The sonoanatomy is clearly documented, and the position of the cervical medial branches is confirmed [8, 9]. The validated procedure comprises precise needle insertion on the cervical articular pillars under fluoroscopic C-arm guidance for both radiofrequency ablation and blocking the medial branches with local anesthesia. Traditionally, imaging guidance like computed tomography (CT) scan and fluoroscopy is used during spine interventional

treatments for managing pain. Using ultrasonography-assisted guiding as a substitute for fluoroscopy-guided placement of needles is a possible solution. [9].

By using a radiation-free imaging approach, vessels along the needle's trajectory may be identified and avoided [10]. When performing operations on the cervical spine, sonography is a great tool for "visualizing" and therefore "avoidance" vascular injury. Due to dynamic imaging, we can prevent constantly adjusting the C-arm to get a correct lateral view of the cervical spine and avoid the parallax effect [11]. To our knowledge, no other previous studies evaluate the long-term efficacy of ultrasound guidance for cervical medial branch neurotomy using radiofrequency ablation in relieving facetogenic chronic neck pain, so we will conduct our study.

The purpose of this research was to assess the efficacy of the ultrasound guidance in radiofrequency ablation of cervical medial branch in cases of chronic neck pain with facetogenic origin.

Materials and Methods

The research was done after approval from the Ethical Committee Tanta University Hospitals (approval code: 34807/7/21). An informed written consent was obtained from relatives of the cases. 30 individuals, ranging in age from 20 to 70, participated in this prospective, randomised trial, both sexes, diagnosed as chronic neck pain with facet origin for three or more months, no history of rheumatic disease + normal ESR and CRP, cervical MRI free (no cervical discs of clinical importance to be included in pain generation), failure of conservative medical treatment as non-steroidal and pregabalin combination and physiotherapy and reported symptom reduction of 80% with concordant dual medical Branch Block before CMBRFA as recommended by The SIS [5].

After receiving permission from Tanta University Hospitals' Ethical Committee, the research was carried out. The patient or their relatives provided their informed written permission.

Exclusion criteria were cervical MRI with considerable disc disease or other degenerative changes that may be pain generator, negative response to medial branch block > 80% symptom relief, local or systemic infection, allergy to local anaesthetics and patients with coagulopathies.

Our study was conducted in two steps: first step, median branch block of cervical facet contributing in patient's neck pain with blocking one level above and one level below using Ultrasound guidance then assessing the pain change by Visual Analogue Scale. Second step, patients with ≥ 80% symptom relief were included for thermal radiofrequency ablation of median branch. According to the SIS patients should be chosen for CMBRFA based on 100% symptom relief but we followed 80% symptom resolution as concluded from a previous study to be more applicable [5]

Preoperative evaluation

Coumadin (warfarin) was stopped 5 days prior to the injection date. Before patient admission to operative room 20G cannula was inserted. Intraoperative standard monitors were applied for measurement of non-invasive blood pressure, oxygen saturation via pulse oximetry, and heart rate utilizing electrocardiograms.

Cervical Medial Branch Block

The prone posture was used for the patients. In the customary sterile manner, the skin was prepared and draped. At each location, 1 mL of 1% lidocaine was used to anesthetize the skin and subcutaneous tissue. The facet joints were avoided when local anaesthetic was applied there. A high frequency linear transducer was positioned longitudinally with its upper end just beneath the mastoid process. The transducer was steadily moved in a caudal direction to observe the lower facet joints once the C2-3 joint was located, until the intended level of the cervical facet joint was achieved. The nerves typically appear as a curvilinear hypoechoic band encircled by a hyperechoic halo in the region of articular grooves. The needle was inserted just caudal to the US transducer and progressed to the target nerve (in-plane) while being monitored by real-time ultrasonography. Smaller MBB volume use would improve specificity. Therefore, the local anaesthetic amounts employed for prognostic MBB ranged from 0.3 mL to 1.0 mL. VAS was used to access the rate of nerve block success and only patients with ≥ 80% symptom relief with dual MBBs were included for thermal radiofrequency ablation of median branch.

Radiofrequency denervation procedure

We injected 0.5 ml of local anaesthetics according to the US information regarding the nerve's location, and then, once we had a clear view of the desired cervical medial branch to be abated, the radiofrequency needle with an active tip was inserted just caudal to the US transducer and progressed to the target nerve (in-plane) under real-time ultrasonography. The nearby tissue was heated for 90 s at an 80° C determined tissue temperature using a NEUROTHERM ® NT1100 RF generator. After the procedure was completed, the patients were advised to apply ice as needed to the area for the first 24-48 hours as this would help with some of the pain from the needle entry.

Measurements

Post-treatment pain relief was assessed using VAS (pain scale, 0 to 100); A pain reduction rate of more than 50% when at rest was considered an objective success of the therapy. The follow-up time periods were promptly after treatment as well as a week, a month, three months, and six months afterwards.

Improvements in cervical function have been made using the Arabic version of the Neck Disability Index. (NDI). The NDI was created using the Oswestry Low Back Pain Disability Questionnaire as a model. There are ten questions in all, including subjects like: pain severity, self-care, reading, lifting, headaches, attention, sleeping, driving, work, and recreation. Scores range from 0 (no disability) to 5 (total disability), for each item. 50 is the highest possible score. The follow-up time periods were right away after treatment as well as one week, one month, three months, and six months afterwards.

Both doctors and researchers employed the NDI, which has now become a standard tool for assessing self-rated neck pain impairment. Scores range from 0 to 5 for each of the 10 items. The highest score was 50. The resultant score might be multiplied by 2 to generate a percentage score. The first report included the following score ranges for interpretation: 0 to 4 = no disability, 5 to 14 = mild, 15 to 24 = moderate, 25 to 34 = severe, more than 34 = total.

Patients' satisfaction was scored as excellent, good, fair, or poor utilizing the modified Mac-Nab criterion. "Excellent"

and "good" results were rated as satisfying, while "fair" and "poor" outcomes were rated as unsatisfactory.

Excellent: No pain; no limitations for activities. Good: Periodic pain in the neck severe enough to prevent the patient from doing his or her regular duties or from taking pleasure in their free time. Fair: Increased functional ability, but limited by intermittent pain that limits or modifies work or leisure activities according to its intensity. Poor: Needs more operational intervention; no improvement or inadequate improvement to allow increase in activity.

Relevant complications like complications from injections, bleeding, allergies, infections, and neurologic deficits were recorded.

Sample size calculation

EpI-Info 2002, a statistical program created by the World Health Organization (WHO) and the Centers for Disease Control and Prevention, was used to calculate the sample size. The following factors were considered while determining the sample size: The projected range for the study's main outcome (pain alleviation), which had a 95% confidence limit and 80% power, was 60% to 90%. To overcome dropout, 5 cases were added, therefore, we recruited 30 patients.

Statistical analysis

The computer was supplied data, which was then analysed using version 20.0 of the IBM SPSS software package. (Armonk, NY: IBM Corp). Number and percentage were used to describe qualitative data. The mean, standard deviation, range (minimum and maximum), and median were used to characterize quantitative data. The Friedman test and the Post Hoc Test (Dunn's) used for comparisons between more than two periods and for quantitative variables with an abnormally dispersed distribution. At the 5% level, significance of the findings was determined.

Results

Demographic data of the patients and distribution of the cases being researched by sides: 12 patient (40%) unilateral and 18 patient (60%) bilateral. Table 1

Distribution of the examined cases based on ablated facets: C2–C3 4, C3–C4 17, C4–C5 17, C5–C6 30 and C6–C7 24 taking in consideration that there were facets that were ablated bilaterally. Figure 1

Change in Visual Analogue Scale and the percent of reduction of VAS compared to pre-operative Score. There was significant change of VAS after one hour, one week, one month, three months and six months. Table 2.

According to changes in Arabic version of Neck Disability Index at pre-operative, after 1 week, 1 month, 3 months and 6 months respectively. Our results demonstrated a considerable change of The Arabic version of Neck Disability Index after one week, one month, three months and six months. Table 3

According to comparisons between the several participants under study, according to Degree of NDI at different periods, the results were statistically significant at $p \leq 0.05$ at different periods of measurements with no complete disability after one week, one month, three months and six months respectively. Table 4

Changes in modified Mac-Nab criteria. The results were statistically significant at $p \leq 0.05$ at different periods of measurements. Table 5.

Discussion

Our study is the first one evaluating the long-term effectiveness of ultrasound guidance in ablating the cervical medial branch using radiofrequency ablation in participants with chronic neck pain of facetogenic origin. Moreover, our study is unique as it's the first to use Arabic Validated Version of Neck Disability Index.

The main objective impel to conduct our study, aiming to change from fluoroscopic Guided towards Ultrasound guided techniques, was the advantages of the ultrasound usage as it is Radiation-free imaging, Compared to fluoroscopy or CT, it takes much less time, is capable of identifying and avoiding blood vessels in the needle's trajectory, and provides dynamic real-time imaging of the cervical spine [12]. Other pearls are its availability in many theatres. The specific cause to our study was the many recent studies done on the in vertebral artery anatomy in this perilous area of the body with very crucial structures that cannot be identified by fluoroscopy which obligate us to use more specific technique for our intervention as ultrasound.

Supporting our proposition, Bruneu *et al* [13]. The most frequent level of entrance for the vertebral artery through the transverse foramen is at C6, which happens in 90–95% of individuals. Although uncommon, anatomical differences in the VA entrance level have been observed in 6–10% of all instances. It was also determined that VA entries at the C3, 4, 5, or C7 level represented 0.2%, 1.0%, 5.0%, and 0.8% of all instances, correspondingly.

The most frequent vascular injury and potentially catastrophic complication of cervical spine surgeries is vertebral artery injury (VAI) [14]. A recent systematic review by Turgut *et al*. [15]. Demonstrated that VA (86.6%) were the vessels that were most often harmed subsequent to cervical spine surgery. Due to early and late-onset bleeding, pseudo-aneurysms, arteriovenous fistulae (AVF), embolism, thrombosis, and cerebral ischemia, VAI may cause serious neurologic impairment and even death. [16].Inspired us to conduct our unique study, the amazing cadaveric study done be Lee *et al*. [9]. Who performed a sonoanatomic study in five fresh cadavers to describe and evaluate a radiofrequency cervical medial branch neurotomy procedure guided by ultrasound? a cervical medial branch neurotomy with ultrasound guidance was successful as they ablated 30 of 34 cervical medial branch, employing the sonographic long axis and cross axis views that have been provided for needle guiding and these results were confirmed with histological examination of the nerves in these cadavers, also, It was demonstrated that it is simple to locate the target site on the curved lateral face of the articular pillars, rapidly position the RF needle, and then perform further neurotomies that would coagulate the medial branch. This was confirmed by fluoroscopy.

Concerning pain assessment using Visual Analogue Scale (VAS) from 0 to 100, the mean pre interventional VAS was (83.17) significantly decreased at all times of the study to (22.83, 24.50, 26.00, 27.17 and 28.00) with mean reduction percent of pain index (72.82%, 71.13%, 69.18%, 67.78% and 66.84%) at one hour, one week, one month, three months and six months respectively.

Hand with hand supporting our finding, Burnham *et al* **[5].** Their results showed no significant variation among both groups, this demonstrates that equivalent clinical results may be achieved using more flexible criteria as opposed to a stricter selection paradigm. So, we used ≥ 80% symptom

relief in our present study.

Our findings were corroborated by Awad *et al*. [17]. In their findings, both groups demonstrated a substantial improvement from facet ablation both one hour after the treatment and one month later with a significant decrease in VAS ($p< 0.05$). However, following the intervention, there was no substantial difference between the fluoroscopy and ultrasonography groups ($p>0.05$). As with our work, they concluded that the cervical spine's ultrasound-guided facet joint ablation is efficient as needle tip could be easily visualized and the technique could be applied easily with minimal risk supporting the outcome of significant pain relief. But this study was limited by its weak design as inclusion and exclusion criteria was not well established, low number of the patients, didn't document their study with images, the lack of measurements of patients' satisfaction and follow up was only for one month after the procedure. Beside all of that although their study was conducted on Egyptian patients, they didn't use Arabic validated psychometric assessment tool.

The Neck Disability Index (NDI) was the first tool created to evaluate individuals with neck discomfort who self-rated their degree of disability. Development of the Arabic NDI was made by Shaheen *et al*. [18]. Who conducted cross-cultural modification of an outcome questionnaire in Individuals with Neck Pain came to the conclusion that the Arabic version of the NDI is a valid, accurate, and flexible tool that is capable of being utilized for evaluating neck pain in Arabic-speaking individuals who have neck pain. It has a 2-factor 10-item structure. As a result, it may be suggested for use in research and clinical applications.

As regard to our findings, there was substantial improvement in the Arabic version of NDI ($p<0.001$) at all times of the study.

Moreover, Laxmaiah Manchikanti *et al*. [19]. Studied the cost utility of cervical therapeutic MBBs in managing chronic neck pain. Their outcomes revealed over the course of the two years, each patient had an average of 5.7 ± 2.2 operations, with substantial reductions in both NRS and NDI pain levels.

MacNab criteria was used throughout the years since 1971 in evaluating patients' satisfaction in more than 21.000 studies in google scholar research so proven validity is certain. Modified MacNab Criteria exist. Who adjusted the instrument and when it was done are both fairly difficult to determine. It seems that everyone adjusted the wording to provide a better and more comprehensive description of the categories, even though the original one remains the same. (Excellent, Good, Fair, and Poor).

Our results showed significant improvement in modified mac-nab criteria through different times of evaluation and follow up till 6 months. Modified mac-nab criteria was used in previous studies to assess patients' satisfaction, thus supporting our study. JF Leon *et al*. [20]. Revealed a good and excellent result on the MacNab criterion indicates success. According to their findings, the VAS was 7.3 before the surgery was performed but decreased to 1.7 after a year. When using the MacNab criterion 12 months after the procedure, 91.7% of the patients had acceptable (excellent and good) results.

Limitations: whole study was only six months follow up. The relatively small number of the cases. Absence of blindness either for the patients or the interventionists through the intervention. Absence of shame control group. Further studies with different additives, different concentrations and different volumes of the LA are required.

Table 1: Demographic data, distribution of cases according to sides.

	Mean ± SD
Age	41.97 ± 10.06
Sex	Male = 14 (46.7%)
	Female = 16 (53.3%)
BMI	27.33 ± 2.39
Side	Unilateral = 12 (40.0%)
	Bilateral 18 = (60.0%)

Data are presented as mean ± SD or frequency (%). BMI: Body mass index

Table 2: Change in Visual Analogue Scale and percent reduction of VAS compared to pre interventional VAS.

Change in VAS		
	Mean ± SD	**P value**
Pre	83.17 ± 11.78	-
1hour	22.83 ± 12.30	<0.001*
1week	24.50 ± 13.73	<0.001*
1 month	26.0 ± 13.73	<0.001*
3 months	27.17 ± 14.12	<0.001*
6 months	28.0 ± 14.18	<0.001*
Reduction in VAS from pre		
1hour	72.82 ± 13.58	
1week	71.13 ± 15.41	
1 month	69.18 ± 15.45	
3 months	67.78 ± 15.79	
6 months	66.84 ± 15.76	

P: P value for Post Hoc Test (Dunn's) for Friedman test for comparing between Pre and each other periods; VAS: visual analogue scale *: Statistically significant at $p \leq 0.05$

Table 3: Change in Arabic version of NDI

Change in NDI		
	Mean ± SD	**P value**
Pre	38.20 ± 6.53	-
1week	12.37 ± 7.88	<0.001*
1 month	13.37 ± 8.21	<0.001*
3 months	13.87 ± 8.36	<0.001*
6 months	14.53 ± 8.39	<0.001*

P: P value for Post Hoc Test (Dunn's) for Friedman test for comparing between Pre and each other periods; NDI: Neck Disability Index *: Statistically significant at $p \leq 0.05$

Table 4: Comparison between the different studied periods according to degree of NDI

NDI / OF 50	**Pre (n = 30)**	**1 week (n = 30)**	**1 month (n = 30)**	**3 months (n = 30)**	**6 months (n = 30)**	**P**
No disability (0-4)	0 (0.0%)	5(16.7%)	5(16.7%)	5(16.7%)	4(13.3%)	<0.001*
Mild (5-14)	0 (0.0%)	12(40.0%)	12(40.0%)	12(40.0%)	12(40.0%)	
Moderate (15-24)	0 (0.0%)	11(36.7%)	9(30.0%)	8(26.7%)	9(30.0%)	
Severe (25-34)	8(26.7%)	2(6.7%)	4(13.3%)	5(16.7%)	5(16.7%)	
Complete (above 35)	22(73.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
P_0		<0.001*	<0.001*	<0.001*	<0.001*	

Fr: Friedman test, Significant between periods was done using Post Hoc Test (Dunn's) p: p value for comparing between the different studied periods; p0: p value for comparing between Pre and each other periods; *: Statistically significant at $p \leq 0.05$

Table 5: Change in modified Mac-Nab criteria

Modified Mac-Nab criteria					
	Pre	**1week**	**1 month**	**3 months**	**6 months**
Excellent	0 (0.0%)	18 (60.0%)	18 (60.0%)	18 (60.0%)	18 (60.0%)
Good	0 (0.0%)	12 (40.0%)	12 (40.0%)	11 (36.7%)	11 (36.7%)
Fair	8 (26.7%)	0 (0.0%)	0 (0.0%)	1 (3.3%)	1 (3.3%)
Poor	22 (73.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
P value	-	<0.001*	<0.001*	<0.001*	<0.001*

P: p value for Post Hoc Test (Dunn's) for Friedman test for comparing between Pre and each other periods *: Statistically significant at p ≤ 0.05.

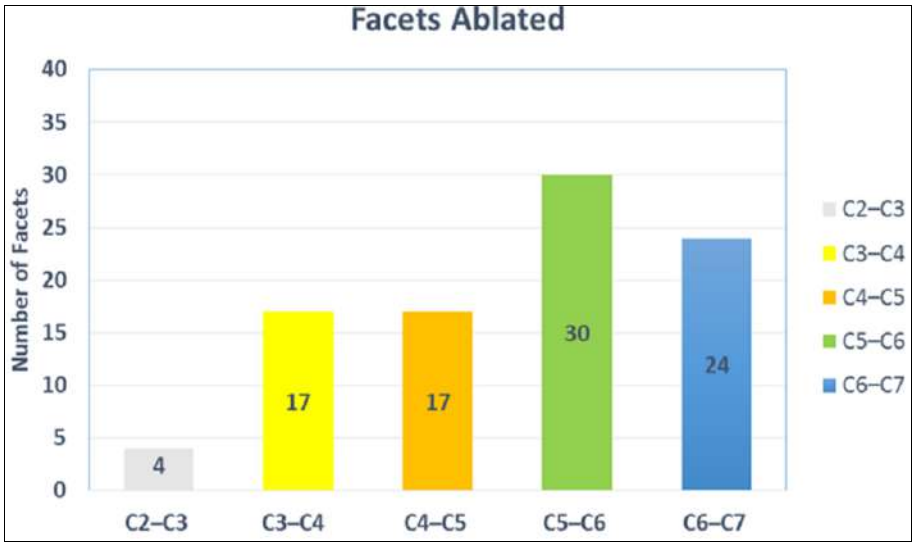

Fig 1: Distribution of patients according to facets ablated

Conclusions

Chronic neck pain resulting from zygapophysial joints origin may be effectively and safely treated by ultrasound guided CMBRFA.

Acknowledgement

There is none to be declared.

Conflict of interests

None to be declared.

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