



**National University of Medical Science, Spain
(NUMSS)**

**Title: The effect of acetic acid (2%) iontophoresis on the
calcification deposit of the shoulder**

BY

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Case-research article

Title: The effect of acetic acid (2%) iontophoresis on the calcification deposit of the shoulder

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Introduction:

One of the worst shoulder pain that causes dysfunction of mechanical type around the shoulder joint is the deposition of hydroxyapatite crystals in the rotator tendons of the shoulder (Rotator cuff) that is known calcified deposit or shoulder calcific or calcification tendinitis (1,3, 9).

Calcium deposits around the shoulder most commonly occur in the burse (outside of rotator cuff) and into supraspinatus tendon at the people over 30 to 60 years (most people over 40 years) (1,2,3,4,5,6,9,13,18 24).

So far, the real cause of this condition is unknown (2,3,4) , but several mechanisms have been proposed for its incidence .

Codman and his colleagues, pointed that the cause of degeneration of the rotator cuff tendon are wear and tear process in that cell necrosis and tissue hypoxia create the endochondral ossification process and it transforms tenosit cells into chondrocyte cells and it causes the formation of calcification. (6 , 7)

Uthoff and sarkar expressed other theories except degeneration process ; they proposed reactive and dynamic process by triggering a cell-mediated in the area, followed by phagocytose of multi-nuclear cells leads to the formation of osteoblastic cells (3,6).

The third theory is the extra bone formation by mesenchymal stem cell metaplasia, so the normal cells exist in tendon tissue, can change into bone form (7,19).

Calcium deposits despite of normal metabolism of calcium and the normal amount in the blood, happens.

In any case, the delay in the process of repair and recovery is one of the major causes calcium deposit in addition to the aforementioned causes (delay healing) (4).

This problem is mainly with sudden and surprising pain and is not related by position or activity and sometimes can be severe like tooth pain. Pain is extreme and intensified within 24 to 48 hours so that the patient holds his arm with the other hand for alleviate and no desire for doing any active or passive movement.

The pain worsens by the elevation of arm and sleeping on involving shoulder. Even in such condition, the patient may induce the narcotic drug for pain relief (2) . There are other complaints with this disorder such as muscle weakness in shoulder elevation, catching and snapping.

Despite of this complication, some patients may be asymptomatic on radiographic image.

The incidence of this complication has been reported 3-20% in which 25-30% of cases are bilateral (2, 13) .

Despite of many similarities, the differences of these disorders with other common disorders in the shoulder such as impingement syndrome or shoulder capsulitis, is that in recent cases, the pain usually begins gradually and are directly related with activity and status of arm, it means that there is a painful arc of movement. However, the deposition of calcium in the shoulder, the pain can be severe without motion in the shoulder, unlike capsulitis that beginning of the gradual and takes months, the pattern of capsular restriction is not present in calcium deposits, however, long-term sustainable disorders in the shoulder could eventually lead to capsulitis in the joint of shoulder.

The symptoms of acute phase of the calcium deposit maybe subside spontaneously (3, 4) but the symptoms of the condition may be chronic and the existence of calcium deposits takes in the months and even years (5 to 15 years) (9, 8).

Commonly the detection of calcification takes place by using a plain radiograph A/P and Lateral view (outlet view) and also internal and external rotation of the shoulder (6, 13).

Calcification on X-ray images has been divided into three types. 1- (Type I) deposition of high density (High density) 2- (Type II) deposits with distinct borders (well circumscribed borders) 3- (Type III) cloudy sediment (cloudy) (13).

Plain X-ray Imaging is one of the strongest diagnostic methods approved by calcium deposit in the shoulder. MRI is not necessary to detect calcium deposit but more than 95% accuracy in finding calcifications in the pathology associated with complications such as rupture of the tendon, and for this reason it can be valuable (6).

It should be remembered that the diagnosis of this complication is more clinical until radiological (2), Although this idea, makes it difficult to judge about prevalence of this disease, but in fact we judged the patients based on x-ray radiographs and thus we could not have been controlled study in incidence of the disease among people, and therefore providing

the estimation. This study is an attempt to establish the effect of acetic acid iontophoresis treatment and access to research study to document it.

Ionto means ion, phoresis means the transmission or transfer, a physical process in which ions (typically "just ($\mu\text{mol} / \text{cm}^2 / \text{h}$), flow by an electric field, by dispersing in a medium. The main factor of this approach is that the Polarity of chemical substance or drugs for transferring should be clear. In this study the acetic acid is a material with a negative polarity so we should transfer it through exposure to the negative pole of the direct current (DC).

Iontophoresis is a physical therapy modality that although development has long been suggested but for some reason has failed, one of the main reasons are the issue of chemicals and chemical reactions due to unfamiliarity and the other reason is that the direct current use very little in physiotherapy.

The lack of effect of conventional physiotherapy modalities in the treatment of calcium deposit of the shoulder, we were decided to re-flow iontophoresis approach as an effective modality in the physiotherapy of this condition.

With examples and practical actions in this area found that acetic acid iontophoresis for the treatment of calcium deposits can be considered as a strategy of treatment.

The Patients of this study: In this study 10 patients were included with a mean age of 53/7 year and 7 months of the length of complications by following protocol.

Materials and Methods:

Acetic acid solution: Acetic acid solution (manufactured by Merck Germany with the purity of 98%), 2% solution of acetic acid were taken to a volume of 500 cc. The solution were kept in the bottle sealed and covered to prevent light.

For Applying an electrical direct current (DC), we used Power Stim machine for transmission and transfusion solution of acetic acid ion .The machine was manufactured by Engineering of modern medicine (Iran,Isfahan co) . The maximum intensity at this process was 7 mA current output, which was begun 5 mA and the flow was controlled by display. For doing this way, at first we examined the patient and we recorded the range of motion and the limitation of movement in flexion and abduction , as well as pain based on the degree of pain visual analog scale (VAS) and finally the radiographic consideration and size of calcium deposits was recorded . The patient slept on non- infected shoulder (side lying) and infected shoulder is above and was placed for 15 minutes under infra-red radiation on the scapula and trapezius muscles of the shoulder with posterior radiation.

How placement of the electrodes: The patient was in a sitting position and the place of electrodes were cleaned with alcohol. The negative or cathode electrode (active electrode) in the procedure for implantation in the best place on greater tuberosity between the humerus and the acromion process, were put in the gap of glenohumeral joint, or in the place of calcification. Positive electrode or anode at a distance of about 20 to 25 cm from the negative electrode in the supra spinatus muscle was set . Before fixing electrodes on the skin, soaking

a pad floating in acetic acid solution (8 layers of conventional cotton gas) below the cathode electrode placed on the skin in the shoulder. The electrode pad sponge soaked in tap water were put under the positive pole on supraspinatus muscle. The size of both electrodes (4 * 6 cm) and a rubber electrodes were selected . Each electrode were separately fixed and tighten with wide elastic bands on their place



figure1: Power Stim machine, Rubber electrodes, cotton gas, syringe



figure 2: The first patient Figure

After the patient's readiness to start with power and flow to the patient's threshold (5 mA) was increased gradually over 25 to 35 minutes then flow to a maximum of 7 mA scored. At the end of the course and turn off the device and open the electrodes, it was used the current pulse mode ultrasound 1 MHz and intensity of 1.5 watts per square centimeter for 4 minutes on the negative electrode area. In conclusion, patients with pendulum codman,s exercise , left the treatment site. The number of treatment sessions: in the first two weeks we had 5 sessions in each week and in the next weeks we had three sessions. The maximum number of sessions was 30 sessions.

The first case (fig. 3 , 4 and 5) : The patient , 51 -year-old man with right shoulder pain and movement disorders with symptoms of abnormal function of the shoulder about 9 months ago . e He had intermittent pain and was uncomfortable sleeping on the right shoulder . Shoulder range of motion didn't have significant limitation unless the feeling of entrapment click on the angle (80 -100 degrees of Abduction) and 110 degrees of flexion . Isometric muscle tests of the shoulder in abduction and rotation, especially external rotation, was a little painful. But the test of passive internal rotation of shoulder was producing more painful. The degree of pain based on pain scores was 7 of 10. The following radiograph showed a large piece measuring 10 * 28 mm calcium deposit. During each 10 sessions, the size of deposition decreased and pain intensity was reduced to one.



Fig3: The beginning of treatment



fig 4: After 10 sessions



fig 5: After 30 sessions

The outcome of treatment: Pain score after 30 sessions were reported 1 to 10 . Shoulder range of motion was normal and there was no sense clicking on the shoulder. Abduction isometric testing and passive internal rotation showed a small amount of pain. According to the above figure disappearance of calcium deposits is shown during the treatment of process.

The second case (Figure 6 and 7): 58-year-old male patient with left shoulder pain, from a year ago due to a fall on the hand no matter skeletal damage. Pain has been intensified from a month ago after agricultural activities. Pain in forearm and wrist even has been referred. Shoulder flexion in the range of 170 degrees and abduction to 120 degrees has been associated with pain and catching. Pain intensity was measured on a pain score 6 of 10. Isometric muscle tests around the shoulder will not cause major pain. The measurement of calcification was 9 * 5 mm. After 10 sessions of pain score decreased from 10 to 3. The following figure shows a decrease in calcification point density.



fig 6: The beginning of treatment



fig7: After 10 sessions

The third case (Figure 8 and 9): 51-year-old female patient with right shoulder pain and movement limitation around six months ago. The patient also has a history of diabetes. Click and felt pain in the shoulder flexion range of 90-100 degrees and 70 degrees in abduction. Pre-treatment pain score determine 8 of 10 and in end of session pain decreases to 1 of 10. The size of calcification was 11 * 9 mm. The number of treatment sessions was 20 sessions and 10 sessions of that first period, 5 times a week and then continued 3 times a week.

The results of treatment based on radiographic findings are shown as follows.



Fig 8: the beginning of treatment



fig 9: After 20 sessions of treatment

The fourth case (figure. 10 and 11): 60-year-old female patient with left shoulder pain and loss of function from 5 months ago. Range of motion in flexion after 90 degrees and abduction after 60 degree was with a sense of clicking and pain. Pain score at baseline was 7 of 10. The size of calcification was 6 * 4 mm. The number of treatment sessions has continued 10 sessions. The result of treatment, the range of motion without pain and pain scores were determined 1 to 10.

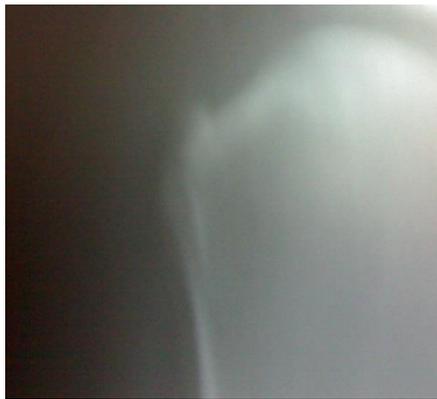


Fig 10: The beginning of treatment



Fig 11: after treatment

The fifth case (Figure 12 and 13): The patient, 68-year-old with a history of nearly a year of weakness and dysfunction on shoulder about 4 months was intensifying. Shoulder abduction to 65 ° and flexion in the higher range of 80 ° to create intense pain and the sense of snapping was associated. Pain score according to the VAS 7 of 10 and patients was upset to sleep on any shoulder .The size of calcification was 22 * 6 mm. After 20 sessions 5 times on week, pain decreased to 2 of 10 and radiograph's symptoms disappear.



Fig 12: The beginning of treatment



Fig 13: after 20 sessions

The sixth case (figure. 14 and 15): A female 45-year-old with a history of shoulder pain than five months ago due to the intensification of pain from 10 days ago for 10 sessions of two weeks was treated for. pain score at the beginning of treatment was 8 of 10 and the abduction of active shoulder 40 degrees and shoulder flexion above 55 degrees was associated with severe pain and also internal rotation as active and passive associated with severe pain. The size of calcification was 20 * 5mm. After 10 sessions, the size of calcification decreased and the intensity of pain decreased to 2 of 10.



Fig 14 : The beginning of treatment



Fig 15: after 10 sessions

The seventh case (figure. 16, 17 and 18): 47 years old woman with a history of seven months of pain and discomfort in right shoulder without trauma, because of increasing pain and limitation of motion in the shoulder she takes 10 days undergoing orthopedic specialist with anti inflammator drugs, the pain and discomfort did not change increasingly. Shoulder impingement test showed positive. Elevation test in shoulder abduction above 80 degrees and flexion higher than the 90 degrees associated with pain and discomfort. The intensity of pain was 7 of 10 and the passive shoulder movement was possible to elevation 150 degrees. The size of calcification was 7 * 4 mm. The patient with iontophoresis protocol was under treatment 20 sessions including 5 times a week. The result of treatment lead to remove calcium deposits in the shoulder compared to the first x-ray, and the intensity of patient pain decreased 1 of 10.



Fig 16: The beginning of treatm



Fig 17: After 10 sessions



Fig 18: After 20 sessions

The eighth case (figure. 19 and 20): The case of 44-year-old female with a history of shoulder pain than five months ago after heavy activity include handling load of 10 kg and gradual onset of shoulder pain afterwards that during the month before treatment intensified. Pain at the night caused discomfort and unable to sleep on the right shoulder. Patient with analgesic and anti inflammator drugs bear the pain, but also she discomforted from the pain and shoulder limitation. Impingement test was positive and restrictions on movements of abduction above 60 degrees and flexion above 80 degrees were obvious problem. Pain score was 7 of 10 and the size of calcification was 6 * 3. After 10 sessions the pain score reached to 1 of 10 and the size of calcification decreased.



Fig 19: The beginning of treatment



Fig 20: after 10 sessions in treatment

The ninth case (figure. 21 and 22): A 55 year old man with a history of pain from two months ago, pain at the night and pain in elevation right shoulder, pain alleviates with pain killer but the patient had problem at the normal activities in shoulder. On examination, abduction above 85 degrees associated with pain and impingement. The movement of shoulder flexion above 100 degrees associated with pain and discomfort. The passive range of motion of the shoulder was near the full range. The shoulder impingement test was positive. The scale of pain has reported 7 of 10 and the size of calcification was 4 * 3mm. After 10 sessions of treatment the pain score reached to 1 of 10 and the calcification disappeared.



Fig 21: The beginning of treatment



Fig 22: After 10 sessions in treatment

The tenth case (figure. 23 and 24): A female 58-year-old with severe pain and limited movement of the right shoulder, the pain gradually begins seven months ago after sports activities bodybuilders in that her pain intensified from two months ago. In the examination, there is tenderness in palpation of the humeral greater tuberosity. The tests of impingement and active and passive in the shoulder is very painful. The range of active shoulder abduction was 25 ° and flexion was 40 ° .The size of calcium deposits was 12 * 6 mm. The scale of pain reported 9 of 10. After 20 sessions, attracting deposits, and pain intensity was reduced from 10 to 1.



Fig 23: The beginning of treatment



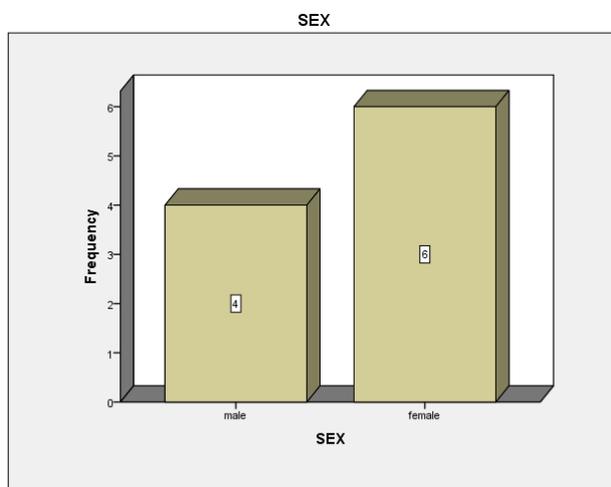
Fig 24: After 10 sessions in treatment

The results: Based on the clinical and radiographic signs, the results of treatment in 10 cases after 10 sessions, were positive and clearly showed the graphs of controlling the absorption of calcification as compared with the first graph of treatment. After the phase of treatment, the patients satisfied of pain decrease and facilitated the return of motion and muscle strength.

[DataSet1] D:\sherkat\anoushiravan mohammvadi\data.

SEX

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid male	4	40.0	40.0	40.0
Valid female	6	60.0	60.0	100.0
Total	10	100.0	100.0	



Frequencies

[DataSet1] D:t\anoushiravan mohammadi\data.

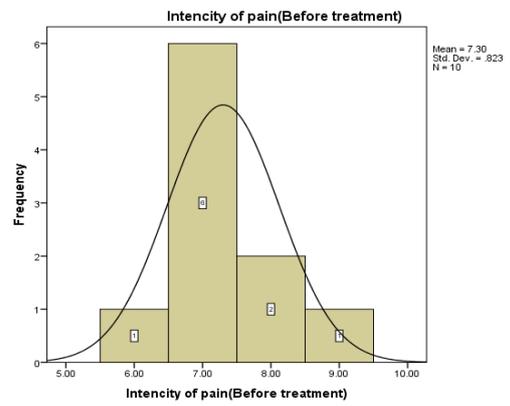
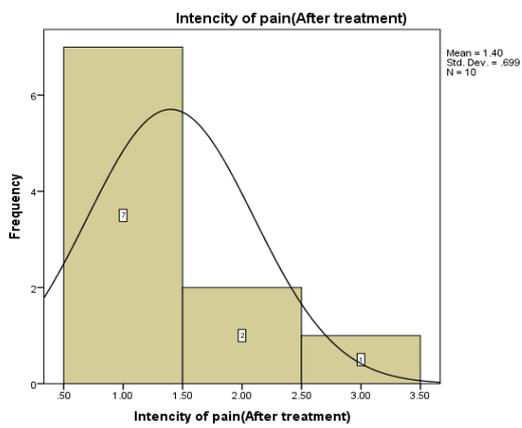
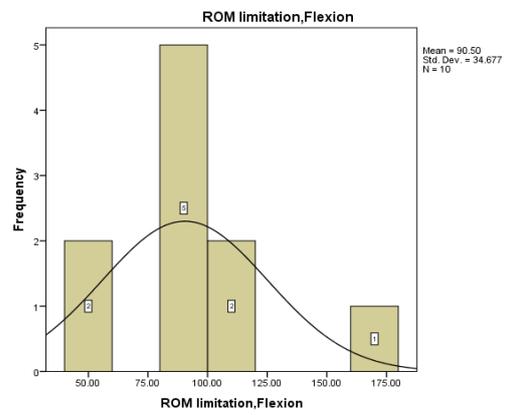
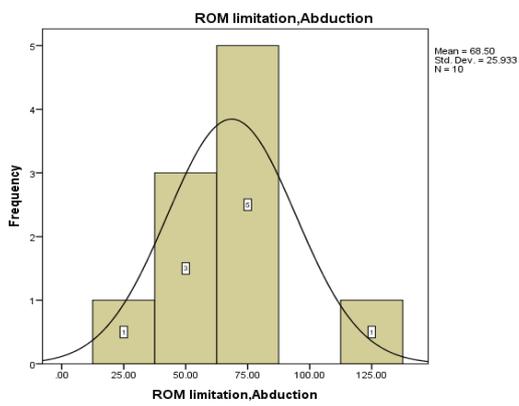
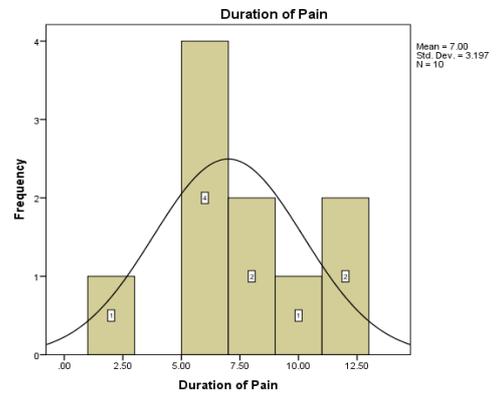
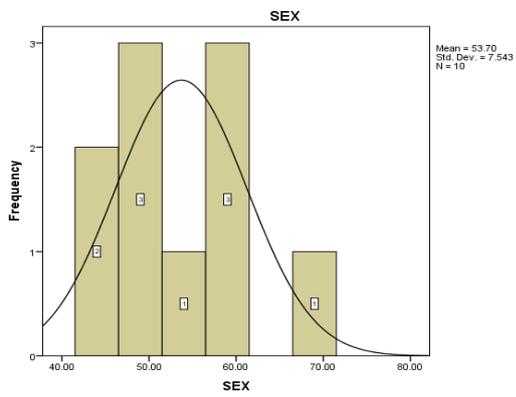
Statistic

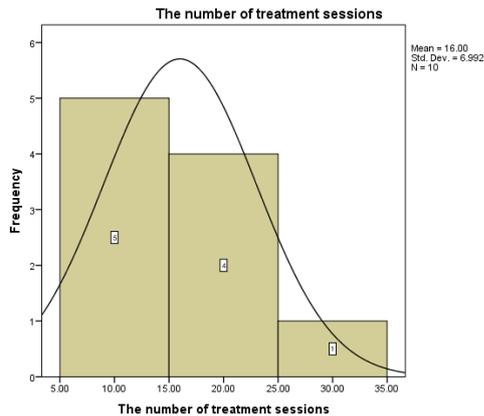
	SEX	Duration of Pain	ROM limitation, Abduction	ROM limitation, Flexion	Intencity of pain (After treatment)
N	Valid	10	10	10	10
	Missing	0	0	0	0
Mean	53.7000	7.0000	68.5000	90.5000	1.4000
Median	53.0000	6.5000	67.5000	90.0000	1.0000
Mode	51.00 ^a	5.00	60.00 ^a	90.00	1.00
Std. Deviation	7.54321	3.19722	25.93260	34.67708	.69921
Minimum	44.00	2.00	25.00	40.00	1.00
Maximum	68.00	12.00	120.00	170.00	3.00

Statistics

	Intencity of pain(Before treatment)	The number of treatment sessions
N	Valid	10
	Missing	0
Mean	7.3000	16.0000
Median	7.0000	15.0000
Mode	7.00 ^a	10.00
Std. Deviation	.82327	6.99206
Minimum	6.00	10.00
Maximum	9.00	30.00

Histogram





Discussion:

Codman and other researcher have been reported common disorders in the shoulder higher than 10 % from 1930(23). Mechanical causes of pain around the shoulder joint and tendon involvement, constitute the majority of cases. Due to anatomical characteristics and high range of motion in different directions and relative instability of the shoulder buildings, the main act sets on tendons and muscles, and therefore, the injuries of repetitive motion are occurring the most common. Although the cause of calcium deposit is unclear in the shoulder (2,3), but the changes tendon wear, necrosis and metaplasia and after the event fibrocartilage in tendon, the tissue hypoxia, are such theories pointed for the foreground crystal material hydroxyapatite (1.4.3). Deposition creates a high pressure sealed container like a cyst on one hand and on the other hand acts as a foreign body.

Although this complication is characterized improvable and they believed that the sediment itself will be absorbed over time, however, as shown in this study were patients treated in chronic phase and changes in the density of calcium deposits with the beginning of treatment quickly occurred.

There are several treatments for calcium deposit on the shoulder, Including: 1- medication drugs (NSAID) 2-physicaltherapy 3-local steroid injection 4- injected by a needle for breakdown and lavage of the deposit (with 60-74 % success rate) (2,3,7,8) 5- shock wave therapy ECSW (30 to 70 % relief of pain and 20 to 77 % absorption of calcification in studies in Germany) (7,8,16) 6-deprival of calcium in food , such as dairy and nuts. It seam, calcium deficiency of the body is the factor that cause to absorb of the pathological calcium deposits (7, 10), but this method should not be used as a stand-alone therapy so that the balanced nutrition with more than 1,000 mg of calcium supplementation in healthy people is necessary especially in women during natural menopause (18) 7-The use of supplements of magnesium (magnesium deficiency increases the phosphor and calcium) (10) 8-in a study by yokoyama in 2003, in 16 patients, **cimetidine** used in calcium deposit for the treatment of chronic shoulder, pain relieved in 10 patients and deposits disappeared in 9 patients(7) 9-More recently, the use of EDTA include intravenous administration of amino acid in which a substance that is used in the treatment of lead poisoning and heavy metals , have been

proposed (14) 10-iontophoresis 11-Surgery (with a success rate of about 90 %) and about 10 % likelihood of further surgery (7). In Wolk and wittenberg reported that conservative treatment was 70% successful (8).

Successful treatment of needling for this problem is mentioned in the medical literature, however hazards such as probability of further damage to the tendon or infection with a needle manipulation compared to treatment of this study makes it risky. New study using shock wave also has taken far the results and it did not result in detailed and clear to solve this problem.

Iontophoresis is not a new technique (11), iontophoresis has begun since 1700 but most of its researchers recognize it since 1900, after working Leduc (19,20,25).Using iontophoresis acetic acid in the treatment of patients with calcium deposits, described first in 1955 by psaki and carroll and then in 1977 by Kabn (19).

Iontophoresis is a technique in which an electric current to drive (deliver) a chemical or drug is given through the skin (25, 26). In fact, it is a needle -free injection and it is used as a non-invasive, painless, low- cost. Iontophoresis is used in laboratory research and particularly useful in Neuropharmacology (12). It is also common treatments for hyperhydrosis. Iontophoresis is an alternative method in the treatment of calcium deposit that it is used this method instead of acetic acid injection. It has no side effects of the needle injection so that entering the needle causes the puncture, bleeding and it could be a field (precursor) calcification forming. This method prohibits in patients with wounds or skin lesions in the treated area, electric current or the chemical hyper sensitivity, patients with Pace maker and in patients with brain disorders, but it can be used in diabetic patients with caution (11). The most problem in the iontophoresis approach is chemical burns at electrodes of treatment site. Considering into the necessary precautions we observed small surface vesicles burned in some patients. In iontophoresis, acetic acid ionized negative charge of Acetate, it penetrates through the skin and can be combined with calcium ions in calcium deposit (calcium carbonate) and creates soluble Calcium Acetate that solved through local circulation (4).



The presence of calcification in the shoulder can press the rotator cuff tendon and cause permanent damage in the parts of tendon (18).

In the present study, although other interventions of physical therapy modalities commonly used for treatment, but so far the lack of acetic acid iontophoresis has poor outcomes and with the addition of this modality the result has surprisingly been different. there are inconsistency reports about iontophoresis (15,16,21,22,26)

In this study it is used the flow rate to 7 mA and time more to 35 minutes. The study has been done in the past, they used time and intensity lower than this present study. Moreover the type of acid produced and the amount dipped in the acid acetic solution (as in treatment time, drying pad was again wet by syringe including acetic acid) and 5 sessions per week of treatment were different in this research into available articles. In this study Because of pain

intensity and lack of precision in Active shoulder rotation, it was used flexion and abduction just in the shoulder.

One of the problems of the present study was the lack of number of patients with clearly calcium deposits in radiographs. As The number of aforementioned samples provide with the assistance of the professional orthopedists in during 1 year. Therefore in this study we couldn't use control group for comparison because there weren't enough patients. In this research the difference has shown in radiographic and clinical improvement as well as compared to the beginning of treatment. In doing study the researcher faced with a calcification of the hand area that was used this approach and the result of treatment for both therapists and patients is amazing.

33 -year-old male patient with a history of 10 months of trauma to the fourth metacarpophalangeal joint during volleyball playing with collateral ligament sprain of forth finger in that after the following radiography to eliminate calcification was treated for 10 sessions. x-ray results after 10 sessions of treatment for the patient and therapist, was stunning.



The beginning of treatment



After 10 sessions

Conclusion: In the present study with a limited number it was seen a supremacy between women with the mean age lower as compared to males (statistical analysis and histogram).

The average age of about 53 years of involvement in both sexes, which is consistent with research done in this field.

The mean duration of the onset of pain was about 5-7 months. Pain intensity based on the scale (VAS) at the beginning of treatment, about 7 to 10 at the end of treatment to around 1.05 from 10 declined significantly.

The average of joint limitation of motion in the shoulder Abduction about 75 degrees and the Flexion about 100-80 degree has obtained, and it is indicated that the priority of the limitation of shoulder Abduction relative to Flexion.

In this study the average of number of treatment sessions, it has been obtained 10 sessions.

The measurement of calcium deposits in the shoulder has strictly declined after treatment.

How to change the size and extent of calcium deposits showed that a decrease in the density and calcium reabsorption increased by the iontophoresis acetic acid during the course of treatment, and with the increasing the number of sessions. With the final treatment, the signs of dense calcification were not observed. On the other hand it can be stated that this is age-related complication occurs mainly in middle-aged or older and on the other hand it is considered as a chronic condition. Also click and clinical particularly felt trapped shoulder rotator cuff tendon depended to two factors, one as much as the deposits, other is to the amount of space available of acromio humeral joint. It is considered that the patient has enough space in this area despite a larger deposit, the impingement symptoms were mild

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The measurement of calcium deposits in the shoulder has strictly declined after treatment.

Recommendation: more systematic research with a larger sample and different methods without interfering with other physical modalities for evaluating the effect of this treatment is recommended.

This method can be used in similar diseases such as myositis ossificans, calcium deposits in other peripheral joint, frozen shoulder, heel spur.

Keywords: shoulder, calcific, calcium deposit, calcification, iontophoresis, acetic acid

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