

CASE SERIES

PAIN MEDICINE

Effectiveness of ultrasound-guided perineural hydro-dissection with 5% dextrose for pronator teres syndrome: a case series

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ABSTRACT

Pronator teres syndrome (PTS) is a proximal compressive neuropathy of the median nerve at the elbow level by the pronator teres muscle leading to pain and numbness in the area of the nerve distribution. Conservative treatment may be effective in 50-70% of cases with extremity rest and non-steroidal anti-inflammatory drugs, corticosteroids, and surgical decompression. Dextrose perineural hydro-dissection under ultrasound guidance is an interventional therapeutic option in cases of peripheral neuropathy due to nerve entrapment. This is a serial case study investigating the efficacy of dextrose perineural hydro-dissection for long-term pain relief in PTS. A numeric rating scale (NRS) and Quick-DASH (Quick-Disability of the Arm, Shoulder and Hand) were used to evaluate pre- and post-treatment states with ultrasound-guided 5% dextrose hydro-dissection therapy. All patients experienced satisfactory resolution on evaluation twelve months after treatment. In long-term evaluation, dextrose perineural hydro-dissection exhibits good clinical and functional outcomes for patients with PTS.

Abbreviations: CTS - carpal tunnel syndrome; HD - hydro-dissection; NRS - numeric rating scale; PTS - Pronator teres syndrome; Quick-DASH - Quick-Disability of the Arm, Shoulder and Hand

Key words: Pronator Syndrome; Pain; Perineural Hydro-Dissection; Median Neuropathy

Citation: Tua Siahaan YM. Effectiveness of ultrasound-guided perineural hydro-dissection with 5% dextrose for pronator teres syndrome: a case series. *Anaesth. pain intensive care* 2023;27(5):607-613; **DOI:**

[10.35975/apic.v27i5.2318](https://doi.org/10.35975/apic.v27i5.2318)

Received: July 11, 2023; **Reviewed:** August 27, 2023; **Accepted:** August 27, 2023

1. INTRODUCTION

Pronator teres syndrome (PTS) is a syndrome of the proximal median nerve irritation due to compression by the pronator teres muscle or the surrounding anatomical structures.¹⁻⁴ PTS results from entrapment of the median nerve between the heads of the pronator teres muscle or at the fibrous arch of the origin of the flexor digitorum superficialis passing between its humeral and ulnar heads.² This syndrome is included in the various rarely occurring peripheral neuropathies of the median nerve, such as carpal tunnel syndrome (CTS) and anterior interosseous nerve syndrome.² A study reported the prevalence of PTS in only 5% of all cases of median nerve neuropathy.^{3,5} The entrapment of peripheral nerves

interrupts nerve microcirculation and results in ischemia, which could cause numbness, paresthesia, neuropathic pain, muscle atrophy, and weakness. PTS clinically manifests itself as pain in the anterior of the forearm, triggered by repetitive activities, primarily pronation or supination of the forearm and flexion of the fingers.^{3,6} This repetitive activity results in hypertrophy of the muscles through which the median nerve passes and triggers neuroinflammation, demyelination, and perineural fibrosis.^{2,3,6} PTS is characterized by numbness in the first three fingers and the lateral aspect of the fourth finger according to the branching of the median nerve.³

Most patients with PTS show excellent recovery, returning to light duty in approximately three weeks and

regular duty, six weeks after receiving muscle relaxation therapy.⁷ Conservative treatment includes modification of activities that exacerbate the symptoms, physical and occupational therapy, non-steroidal anti-inflammatory medications, and local injections with corticosteroids or local anesthetics. Surgical intervention is needed if conservative treatment does not yield significant results or the patient experiences weakness or motor atrophy.⁷ Minimally invasive techniques such as ultrasound (US)-guided perineural hydro-dissection (HD) can be used as an alternative treatment for nerve entrapment to avoid surgery and associated complications.⁸

Perineural HD is a technique that uses high-resolution US-guided fluid injection to separate nerves from the surrounding or adjacent structures, usually the fascia, which is believed to constrict or irritate the nerve either during movement or at rest. This technique is considered safe and effective, especially in cases of nerve clamping, including PTS.^{4,6,8} Mild compression of the vasa nervorum would first affect venous outflow, with potential stasis and accumulation of toxins at the affected part of the nerve. Therefore, the primary objective of HD is to release the entrapment of the peripheral nerves by hydro-dissecting the nerves.⁹ Fluids used in the HD include normal saline (NS), corticosteroids, 5% dextrose (D5W), and platelet-rich plasma (PRP).^{4,9} Randomized controlled trials have suggested that this technique can safely and effectively treat CTS, the most extensively studied clinical condition treated by ultrasound-guided HD of peripheral nerves.¹⁰ D5W is commonly used in clinical practice as its administration has no significant side effects.⁸ However, the use of D5W HD in managing PTS has yet to be reported. This case series found considerable improvement in 1-year follow-up data of PTS patients after being treated by ultrasonography-guided D5W HD.

2. CASE SERIES

2.1. Case 1

A 50-year-old housewife complained of pain in the proximal area of the left forearm that radiated to four fingers for one month; numeric rating scale (NRS) was 9/10 and Quick-Disability of Arm, Shoulder, and Hands (Quick-DASH) of 45. There was no history of trauma, tumors, and metabolic disorders. Physical examination showed a provocative positive test and a positive Tinel test on the left side. Motor strength on the Medical Research Council scale on both arms was 5/5. Electromyography (EMG) showed a demyelinating-type median motor nerve neuropathy. The patient had taken non-steroidal anti-inflammatory drugs (NSAIDs) and adjusted with lifestyle modifications without significant results.

2.2. Case 2

A 43-year-old woman complained of pain and tingling sensation in her right forearm for one month. On examination her NRS score was 8/10 and a Quick-DASH score was 31.8%. Other records related to metabolic, trauma, and tumor were negative. Physical examination showed provocative positive tests. Motor strength in the both arms was 5/5. EMG showed motor neurons demyelination of the median nerve. Before the consultation, she took NSAID for one week, but without significant improvement.

2.3. Case 3

A 63-year-old driver had a pins-and-needles sensation in the first two fingers of his right hand for two months; with Quick-DASH 9.1%, and NRS 2/10. No trauma, tumor, and metabolic diseases were apparent. Physical examinations showed provocative positive tests, and motor strength of both arms was 5/5. EMG was not performed due to high costs. He had taken NSAIDs for one week and tried physical therapy for a month without significant results.

2.4. Case 4

A 51-year-old office worker had a tingling sensation in the proximal area of his left forearm, that radiated to the first to third of his fingers for four months without pain sensation. He had a Quick-DASH of 9.1%. He had taken NSAIDs for a week and attended a month of rehabilitation therapy without significant results. No history of trauma, tumors, or metabolic diseases was reported. Physical examination revealed provocative positive tests, and motor strength in his both arms was 5/5.

2.5. Procedure

A pain physician with more than ten years of experience in US-guided musculoskeletal procedures performed all therapeutic US-guided perineural HDs. All patients underwent three system sessions under a high-frequency linear transducer musculoskeletal ultrasound device (Philips, USA). A 23-gauge, 2-inch needle was used, and a total of 10 mL of 5% dextrose (Otsu D5, Otsuka) was injected over the long axis of the median nerve by in-plane distal to proximal approach (Figure 1). The second and third injection was performed two weeks after the first injection. Side effects, allergic reactions, or complaints were noted to evaluate whether they were related to the injections.

2.6. Patient Follow-up and Results

The degree of symptomatic relief was assessed after 2 weeks, after 1 month, and after 3 month. Assessment was also done at 12 months after the procedure via telephone

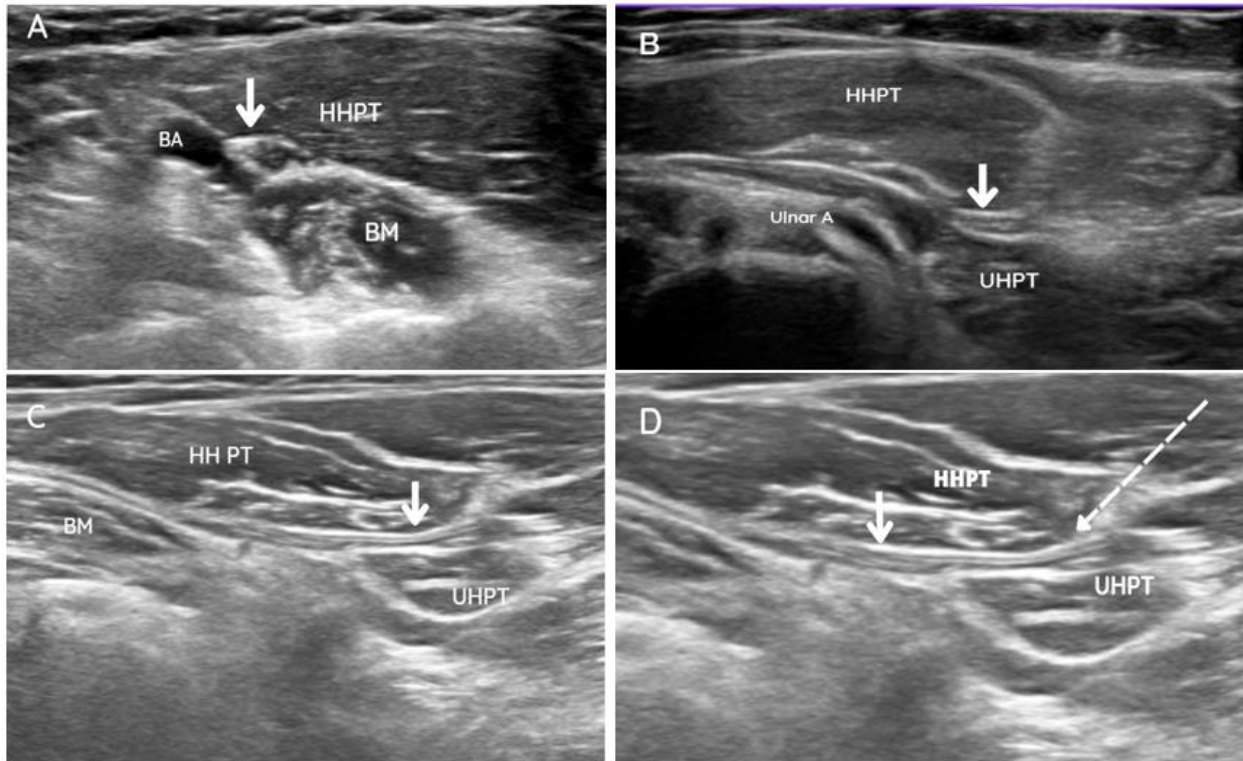


Figure 1 (A and B): Ultrasound images in the short-axis view show the median nerve (white arrows) over the brachialis muscle and between the two heads of the pronator teres. **(C)** A long-axis view of the median nerve (white arrows) in the distal segment is located between two heads of the pronator teres muscle. **(D)** the dotted line arrow indicates the direction of needle placement of perineural hydro-dissection. **BM:** Brachial Muscle, **HHPT:** Humeral Head Pronator Teres, **UHPT:** Ulnar Head Pronator Teres

surveys, shown at Table 1. Patients reported the Quick-DASH scores, shown at Table 2.

Majority of patients felt immediate relieve and recovery of sensory sensation, no more tingling, or pain and needles at 2 weeks follow up. After 1 month, NRS and Quick-DASH scores were also dramatically decreased, and even better on 3 months follow up. Follow up at 12 months aimed to see whether patients experience any recurrence or relapse. Of all patients recruited in this study, none experienced any relapse after 12 months, NRS scores were 0/10 and Quick-DASH scores were also at 0%. All subjects experienced satisfactory recovery on evaluation after treatment. Even in long-term evaluation, subjects exhibited good clinical and functional outcomes. This showed that perineural hydrodissection using dextrose 5% is effective in pronator teres syndrome in these cases.

3. DISCUSSION

The median nerve (MN) arises from the anteromedial and anterolateral cords of the brachial plexus. After

originating from the brachial plexus in the axilla, the MN lies laterally close to the brachial artery and then crosses it anteriorly. After entering the cubital fossa, the MN passes beneath the bicipital aponeurosis, over the brachialis muscle, and then between the two heads of the pronator teres, passing several structures on the way.¹ The most common site of median nerve compression is at the elbow level, between the two heads of the pronator teres muscle.^{1,2} Light nerve compression results in structural changes of the nerve, including nervi nervorum and vasa nervorum, resulting in a neurogenic inflammatory process that produces neuropathic pain.³ In this case series, all patients complained of tingling. Many of them had burning and pin-and-needle sensations from their forearm to their fingers manifested by the compression of the MN. Positive Tinel's sign at the pronator teres muscle's lateral and proximal edge supports the PTS diagnosis. However, specific neurological testing is unreliable for distinguishing entrapment lesions or identifying median neuropathy. Although EMG examinations were carried out in all 4 cases, the examination results did not show a specific

Table 1: Follow up after injection				
Demographic Data	Clinical Manifestation	Physical and Supporting Examinations	Follow-up after both injections	
			< 6 month	12 months
Mrs S, a 50-year-old active stay-at-home parent	Pain and tingling in the proximal area of the forearm radiate to four fingers. NRS 9/10 Quick-DASH 45.5%	Pronator compression test (+) Tinell test (+) Phalen test (-) Upper motor strength 5/5 EMG: demyelinating type median motor nerve neuropathy US: fascicular swelling and epineurial thickening (Fig 2)	After 2 weeks The tingling sensation was disappeared. After 1 month NRS 2/10 in rest position, provoked by repetition movement (Washing or Mopping) Quick-DASH 9.1% After 3 month NRS 1-2/10 Quick-DASH 4.5%	Tingling did not relapse. NRS 0/10 Quick-DASH 0%
Mrs M, a 43-year-old stay-at-home parent. History of contraceptive usage (implant)	Pain in the proximal volar, especially unable to shake direct the right side. Tingling sensation dominates in proximal fingers. NRS 8/10 Quick-DASH 31.8%	Pronator compression test (+) Tinell test (+) Phalen test (-) Upper motor strength 5/5 EMG: motor neuron demyelinating at the median nerve.	After 1 week The tingling sensation diminished. After 1 month NRS 0/10 in a passive activity, worsen with heavy activities. Quick-DASH 6.8 Upper motor strength 5/5 After 3 months NRS 0/10 in an active and passive activity Quick-DASH 2.3%	The tingling sensation did not relapse. NRS 0/10 Quick-DASH 0%
Mr S, a 63-year-old driver	Pin and needle sensation around right hand's 1 st -2 nd fingers of his right hand for two months—no pain complaints. NRS: 0/10 Quick-DASH 9.1%	Pronator compression test (+) Tinell test (+) Phalen test (+) Upper motor strength 5555/5555 EMG: -	After 2 weeks Pin and needle sensation was disappeared. After 1 month Quick-DASH 9.1% Upper motor strength 5555/5555 After 3 months Quick-DASH 0%	Pin and needle sensation wasn't relapsed. Quick-DASH 0%

Mr Y, a 51-year-old office employee	Tingling sensation in the proximal area of the forearm that radiates to 1 st – the 3 rd finger on the left side. NRS: 0/10 Quick-DASH 9.1%.	Pronator compression test (+) Tinell test (+) Phalen test (+) Upper motor strength 5/5 EMG: -	After 1 week The tingling sensation diminished in the resting position but sometimes recurred after lifting heavier things. Quick-DASH 6.8 After 3 month Tingling did not relapse in active or passive activity. NRS 0/10 Quick-DASH 0% Upper motor strength 5555/5555	The tingling sensation did not relapse. NRS 0/10 Quick-DASH 0%
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Table 2. Quick-DASH score for all patients ('1' means 'no difficulty to '5' means 'unable')

Patient	Time	Jar	Heavy household	Carrying shopping bag	Wash your back	Cut your food	Recreational activities	Social activities	Work/regular activities	Pain	Tingling	Sleep	Quick DASH Score
		item 1	item 2	item 3	item 4	item 5	item 6	item 7	item 8	item 9	item 10	item 11	
Mrs. S	Before	4	4	3	2	4	1	2	1	4	4	2	45.5
	After	2	1	1	1	2	1	1	1	2	2	1	9.1
	Evaluation	2	1	1	1	2	1	1	1	1	1	1	4.6
Mrs. N	Before	1	4	4	1	1	1	1	2	4	4	2	31.8
	After	1	2	1	1	1	1	1	1	2	2	1	6.8
	Evaluation	1	2	1	1	1	1	1	1	1	1	1	2.3
Mr. S	Before	1	1	1	2	1	1	1	1	1	4	1	9.1
	After	1	1	1	1	1	1	1	1	1	1	1	0.0
	Evaluation	1	1	1	1	1	1	1	1	1	1	1	0.0
Mr. Y	Before	1	1	2	1	1	1	1	1	1	4	1	9.1
	After	1	1	1	1	1	1	1	1	1	1	1	0.0
	Evaluation	1	1	1	1	1	1	1	1	1	1	1	0.0

diagnosis of PTS. The absence of a mass or hematoma as a cause of nerve compression makes it difficult to diagnose or locate the cause of the nerve compression using ultrasound since the fibrous bands or scar tissue may be too small to visualize in the US.² In conclusion, the diagnosis of PTS in these serial cases was based on clinical symptoms and examination without a particular cause.

Most PTS cases are treated with conservative therapy, including oral NSAIDs, physical therapy, local anesthetics, and steroid injections.^{2,6} If symptoms persist for over six months, surgical interventions may be recommended as a last resort.^{1,3}

In this serial case report, all patients were treated with oral NSAID medications for an average of 1-2 weeks without corticosteroid injection. Lifestyle modifications were performed but did not show significant results. Although corticosteroid injections are commonly used to treat peripheral entrapment neuropathy but were not used in the present study due to their short-term efficacy and the possibility of causing neurotoxicity-induced axon and myelin degeneration.^{1,2} Therefore, finding an alternative injectate for perineural injection is essential to improve the success rate of non-surgical treatments. Perineural HD with ultrasound guidance has been widely applied in cases of entrapment neuropathy, especially for carpal tunnel syndrome.^{4,8} Although Denzell and Patel noted that 75% of patients with steroid HD showed symptom improvement, six other studies on entrapment neuropathy syndrome demonstrated that D5W was more effective than other therapies.⁸⁻¹⁰ In a randomized controlled trial, Wu and colleagues reported that HD with D5W in a patient with CTS was superior to either saline HD or HD with triamcinolone.⁸⁻¹⁰

Although there have not been many studies of HD using D5W in PTS, the success of using D5W HD in treating CTS can predict the success of D5W treatment in PTS. Perineural HD with D5W is performed on the area around the peripheral nerves with ultrasound guidance to release the peripheral nerves from the fascia, covering them to give a decompression effect. We use ultrasound as guidance because ultrasound has become widely accessible and increases accuracy. Injection accuracy is needed because accuracy in dissecting the targeted nerve area can affect the percentage of success of the procedure. The in-plane technique is safer than the out-of-plane technique for dissecting the soft tissue and completely removing the fascia until the injection fluid surrounds the nerve.⁹

Two weeks after receiving the first ultrasound-guided D5W HD therapy, all patients experienced significant pain reduction with a decrease in the NRS score to 50% and a perceived reduction in paresthesia. Nevertheless, the effectiveness of D5W therapy in peripheral

neuropathy is still debated. It is about how it works and how long the clinical improvement will last.

Some studies mention that perineural HD provides a mechanical effect to release and decompress the entrapped nerves and a pharmacological effect relieving pain and promoting recovery through numerous mechanisms.⁶⁻⁸

A hypothesis has been proposed that D5W relieves pain through a sensorineural mechanism by downregulating the transient receptor potential vanilloid-type 1 (TRPV-1), usually upregulated in chronic neuropathic pain.⁹ Recent studies have argued that D5W reduces neurogenic inflammatory processes by blocking the TRPV-1 receptor found on peripheral nerves.^{8,9} When connective tissue is injured, it causes a release of pro-inflammatory substances that activates the TRPV1 channel on certain nerve endings in the C-fibers. When turned on, this channel releases substances that cause inflammation leading to swelling, hypersensitivity, and painful sensations.

Another hypothesized mechanism is that glucose reduces neurogenic inflammation, and reversing hypoglycemic status can decrease C-fibers activation.⁹

In PTS, neuropathic pain occurs due to neural inflammation of the MN due to repetitive mechanical compression.^{2,3,6} Chronic neuropathic pain significantly results in glucopenia of the surrounding nerves and causes a decreased adenosine triphosphate (ATP) activity and Na-K (sodium-potassium) pump, leading to progressive nerve depolarization and hyperexcitability.^{9,10} When the nerve is in a hypoglycemic environment, histopathological changes result in the peripheral nerves and the activation of nociceptive C-fibers with increased noxious signal transduction.⁹ The high activity of C fiber will quickly return to normal after glucose administration; this shows that a 5% dextrose injection will stabilize neural activity, regulate neurogenic metabolism, and reduce neurogenic inflammation, resulting in decreased neuropathic pain.^{9,10} Adenosine monophosphate protein kinase (AMPK) is an enzyme that is very important in regulating cell metabolism. AMPK activity will decrease if hypoglycemia occurs. The increase in glucose will normalize the AMPK activity and affect reducing pain intensity.^{9,10}

Dextrose injection is considered to improve local glucopenia, thereby reducing neuropathic pain that occurs.⁸ Thus, delivering D5W to the perineural soft tissue is constructive for nerve healing after decompression. Indirectly, the HD technique releases adhesions to the surrounding tissue, allowing nerve impulses to be delivered and reducing the risk of ischemia.⁸

During the third injection, the patient experienced a resolution of pain and no tingling sensation. Evaluation for 12 months post-injection was done, and results showed an NRS score of 0, with Quick-DASH 0%, and no sensation problems. Some journals write that at least five injections are to be performed to produce significant results. Still, in this case series, three injections performed at 2 weeks intervals have had a considerable effect, not only loss of pain sensation but also sensory disturbances.^{4,5} Further studies with a larger sample will be needed to understand the effect of dextrose HD on PTS cases in the future.

4. CONCLUSION

Ultrasound-guided dextrose hydro-dissection may be a therapeutic option for pronator teres syndrome. Three injections performed at 2 weeks intervals showed symptoms improvement in all cases. Hopefully, more studies can be conducted with a larger sample and more in-depth discussion.

5. Conflict of interest

The author reports no conflict of interest.

6. Ethical concerns

Informed consents were obtained from all of the patients involved in this manuscript for the procedure and to publish.

7. Acknowledgments

The author would like to thank colleagues from Universitas Pelita Harapan and Siloam Hospital Lippo Village for supporting this manuscript.

8. Authors contribution

Yusak Mangara Tua Siahaan is the sole author of this manuscript.

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