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Effectiveness and Safety in Closed Mini-Transverse Incision with Hydro-Dissection Technique in Carpal Tunnel Release: A Cadaveric Study

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Background: Closed mini-wrist transverse incision for carpal tunnel release has been reported in decreasing surgical scar problems, but there were few cadaveric studies that proved the effectiveness and safety in this technique without protective instrument to the median nerve. Hydro-dissection was previously showed to separate median nerve and deep structures during percutaneous ultrasound guided transverse carpal ligament release. This cadaveric study aims to demonstrated effectiveness and safety of closed transverse carpal ligament (TCL) release though the mini-transverse incision at distal wrist crease combined with hydro-dissection technique. Neither special instrument nor retractor was used to protect neurovascular structures.

Methods: Twelve fresh frozen cadaveric wrists were included in this study. Completeness of TCL release and injury to the adjacent neurovascular structures were assessed by direct visualization. Thickness of TCL, TCL length and distance from incision to adjacent neurovascular structures were also recorded.

Results: Complete release of TCL was demonstrated in all 12 (100%) wrists underwent the mini-transverse incision TCL release at distal wrist crease and hydro-dissection technique. No injury to the adjacent neurovascular structures was found in all 12 wrists. Mean of thickness of TCL and TCL length were 3 mm and 28.7 mm, respectively. The ulnar artery was the nearest structure to the incision (mean = 3.7 mm).

Conclusions: The closed mini-transverse incision TCL release at distal wrist crease with hydro-dissection technique demonstrated completeness of TCL division and safety to the neurovascular structures without protecting retractor or special instrument.

Keywords: *Carpal tunnel release, Transverse carpal ligament, Mini-transverse incision, Hydro-dissection*

INTRODUCTION

Surgical treatment in carpal tunnel syndrome was effective and resulted in good outcomes.[1)] However, post-operative wound complications still occurs such as surgical scar discomfort and pillar pain.[2-4)] Many surgical techniques targeting to decrease incision site including mini-open carpal tunnel release, limited open carpal tunnel release, wrist transverse incision open carpal tunnel release, endoscopic carpal tunnel release and percutaneous ultrasound guided carpal tunnel release had been developed to decrease the complication.[2,5-8)] On the other hand, reduction incision may result in less effectiveness to completely transverse carpal ligament (TCL) releases and more injury to median nerve and adjacent structures.

Mini-transverse incision at distal wrist crease for carpal tunnel release was one of surgical techniques that decrease post-operative surgical scar complication.[8,9)] This

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operation could be performed either by open or closed technique.[9,10] Focusing on closed techniques that may have more chance to incomplete TCL division and nerve damage, normally retractor was used to see and protect median nerve. Specially designed instruments or knives were developed to increase effectiveness and safety. The closed blind TCL release with Knifelight® at distal wrist crease had been shown completeness of TCL release in cadaveric study.[11] However, study about effectiveness and safety of closed blind TCL release without special instrument or retractor though the mini-transverse incision at distal wrist crease was limited.

Hydro-dissection technique for carpal tunnel release was introduced to separate median nerve from deep surface of the TCL during the TCL fenestration.[12] Moreover, ultrasound guided carpal tunnel release was successfully used with hydro-dissection technique to release TCL without any protective instruments for median nerve.[13] However, from our literature review, there was no study which combined hydro-dissection technique and closed blind TCL release without special instrument or retractor. This study aims to demonstrated effectiveness and safety of closed blind TCL release though the mini- transverse incision at distal wrist crease combined with hydro-dissection technique using simple instrument without retractor in cadaveric subjects.

METHODS

This study was approved by Institutional Review Board (Si 434/2017). Twelve fresh freeze cadaveric upper limbs were included in this study. All specimens did not have signs of injury or previous surgical scar.

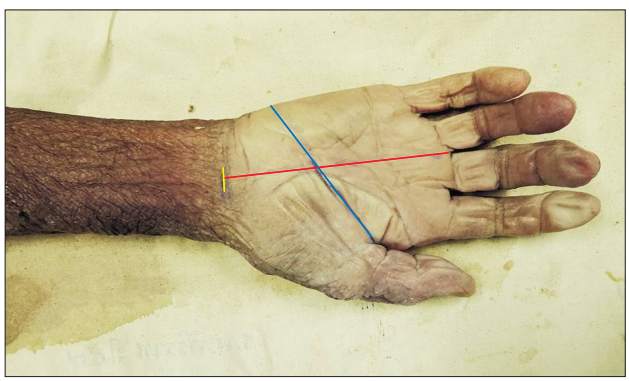

Fig. 1. The Kaplan cardinal line (blue line) and the longitudinal line from radial side of the ring finger to the distal wrist crease (red line) were drawn. The surgical incision was drawn 1 cm in at distal wrist crease (yellow line).

Surgical technique

The cadaveric wrist was placed in 30 degrees of wrist extension. The Kaplan cardinal line and the longitudinal line from radial side of the ring finger to the distal wrist crease were drawn. The surgical incision was drawn 1cm in at distal wrist crease (Fig. 1). The Palmaris longus tendon was identified and retracted radially then the antebrachial fascia was identified and incised as U-shape figure. The 10 ml of normal saline in 10 ml syringe with intravenous catheter needle was injected underneath the TCL (Fig. 2). The 4-mm arthroscopic obturator was used to blunt dissection above and under the TCL (Fig. 3). The surgeon finger presses on the palm at Kaplan Cardinal line to limit the tip of the scissors (Fig. 4). The Jameson tenotomy scissors was gently placed above and underneath the TCL then cut the TCL with steady motion until feeling of give and loss of TCL resistance on complete release. All cadaveric wrists were carefully dissected to check the completeness division of the TCL, the injuries of the adjacent neurovascular structures including the superficial palmar arch, ulnar artery and

Fig. 2. The 10 ml of normal saline was injected with minimal resistance.

Fig. 3. The 4-mm arthroscopic obturator was inserted above and under the transverse carpal ligament.

Fig. 4. The finger was used to limit the tip of Jameson tenotomy scissors.

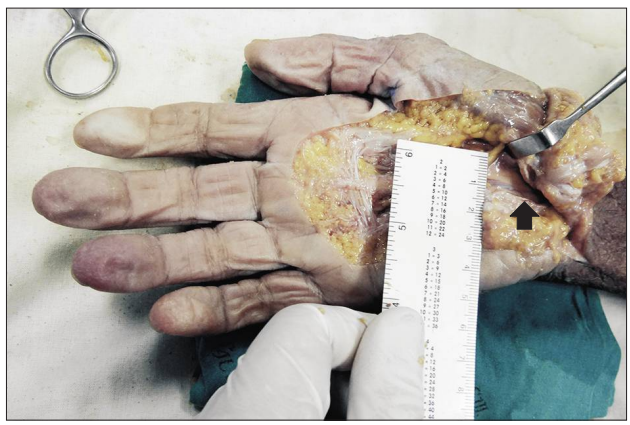

Fig. 5. Completeness of TCL release and the line of TCL division (arrow) were on ulnar side of median nerve.

nerve, palmar cutaneous branch of the median nerve, recurrent branch of the median nerve. Length and thickness of TCL were measured. The distances from incision to the adjacent neurovascular structures as describe by Yoo et al.[10] were record.

RESULTS

Twelve cadaveric wrists from 6 female and 1 male with mean age 63.5 year was used in this study. Complete the TCL release were observed in all cadaveric wrists (12/12 wrists) (Fig. 5). There were no the adjacent neurovascular injuries in all cadaveric wrists (12/12 wrists). All recurrent branch of median nerve were extra-ligamentous type on radial side of median nerve. Mean of TCL length is 28.7 mm and mean of TCL thickness is 3 mm (Table 1). Ulnar artery was the closest structure to the incision (mean 3.7 mm) (Table 2).

Table 1. Measurement of Transverse Carpal Ligament

No.	Side	Sex	Age (year)	TCL length (mm)	TCL thickness (mm)
1	L	F	70	25	3
2	R	F	70	26	3
3	R	F	87	30	3
4	R	F	50	26	2
5	L	F	87	28	4
6	R	F	66	32	3
7	R	F	65	35	3
8	L	F	50	25	2
9	L	F	65	30	3
10	L	F	66	30	3
11	R	M	43	32	3
12	L	M	43	25	4
			Mean ± SD	28.7 ± 3.3	3.0 ± 0.6

Table 2. Measurement Distance Transverse Carpal Ligament to the Adjacent Neurovascular Structures

Distance measured along the line of incision (mm)	Mean ± SD	Range
To palmar cutaneous branch of the median nerve from proximal border of transverse carpal ligament	13.6 ± 3.8	5–20
To recurrent branch of the median nerve from the incision	12.8 ± 2.8	8–18
To superficial palmar arch from distal border of transverse carpal ligament	14.1 ± 5.2	7–20
To ulnar artery from proximal border of transverse carpal ligament	3.7 ± 1.2	2–6

DISCUSSION

Open or closed transverse carpal ligament release techniques at distal wrist crease were reported to have successful clinical outcome in carpal tunnel syndrome treatment.[5,8] Incomplete division or nerve damage were the major concerns for closed mini-transverse incision. Additional retractors or special knife were required to demonstrate entire TCL or to protect median nerve before TCL dissection.[7-9]

This study proposed new combination technique of hydro-dissection and closed blind mini-transverse incision at distal wrist crease for TCL release. Complete division of the TCLs without neurovascular injuries were observed in all cadaveric wrists. This study demonstrated that hydro-dissection yielded effective median nerve protection. Prevalence of ulnar side of motor branch of median nerve by Lanz's classification was

reported as 2.1%.[14] Though, this variation had the possibility to injury if the TCL was divided on the ulnar side of median nerve. In our study, all recurrent median nerves were extraligamentous type on radial side of median nerve and the line of TCL division was on ulnar side of median nerve in all cadaveric hands therefore we did not detected any damage. The ulnar side variant of motor branch of median nerve injury by this technique may be minimal. Closed blind mini-transverse incision might give rise to iatrogenic median nerve injury as the difficulty to access the arthroscopic portal during endoscopic carpal tunnel release.[15] Fluid fill in space above the median nerve from hydro-dissection increased space between TCL and median nerve. The space which was required was approximately 4 mm in diameter because 4-mm arthroscopic obturator and Jameson tenotomy scissors could be used effortlessly to dissect under TCL before TCL dissection. Additionally, 4 mm arthroscopic obturator which had similar diameter to Jameson tenotomy scissors could be inserted to increase surgical space (Fig. 6). The advantage of hydro-dissection is to increase the space between the TCL and median nerve and to decrease direct contact force to the median nerve before arthroscopic obturator insertion. Insertion arthroscopic obturator using hydro-dissection technique reduces the possibility for median nerve injury. The arthroscopic obturator easily passed into carpal tunnel to make sure that no adhesion between median nerve and TCL. Therefore, no additional retractor or protective instruments was required to protect median nerve in this study.

The percutaneous ultrasound guided carpal tunnel release successfully used 10 ml of lidocaine to perform hydro-dissection but this study used 10 ml of normal saline to perform hydro-dissection. In clinical application, the anesthetic medication could be used to relieve pain during the TCL division. Further study may be required to elucidate optimal fluid volume and which fluid to use in hydro-dissection.

In this study, Jameson tenotomy scissors was used to perform 1-cm incision because it was small and had slim shape, which can divided the TCL in single cut, decreased risk of technical errors including incomplete release or neurovascular injuries.

There were several limitations in our study included small sample size and no control group in study design. Even through there was no control group, closed mini-transverse incision without special instrument may have more risk to incomplete release and neurovascular injury. From our literature review, only one previous study performed in cadaver to demonstrate no neurovascular injury from mini-transverse resection with special instrument.[11] Also, our cadaveric study obviously showed complete resection and no adjacent structures injury so we believed hydro-dissection provided additive effect in closed mini-transverse incision.

Regarding sufficient release of median nerve, completeness of TCL releases were demonstrated from all wrists in this study as shown in Fig. 5. For clinical application, previous studies reported the benefit of small wrist transverse incision on more hand function score in early postoperative period and less pillar pain, less scar tenderness and no recurrence of carpal tunnel symptoms in long term follow up when compared with mini-open incision and long open incision in palm.[16,17] Our technique using small wrist transverse incision may give the similar outcome but less cost of special instruments.

There were some limitations of this technique. Normal anatomy of the distal part of TCL is thicker than proximal part and the TCL in carpal tunnel syndrome is also thicker than normal. It may be not easy to release the TCL with tenotomy scissors. The constant force while using the tenotomy scissors to cut the TCL and digital pressurization at the Kaplan cardinal line to limit the tip of scissors until loss of TCL resistance on complete release was the important step of this technique. Although, this cadaveric study has been demonstrated the good efficacy and safety for this technique, further clinical study was required to show effectiveness and safety in clinical outcomes.

In conclusion, this study demonstrated effectiveness and safety of mini-transverse incision at distal wrist crease with hydro-dissection technique in closed blind TCL release.

Fig. 6. Size comparison between the 4-mm arthroscopic obturator and Jameson tenotomy scissors.

CONFLICT OF INTEREST

None declared.

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