The Sensory Restoration in Radial Nerve Injury Using the First Branch of Dorsal Ulnar Cutaneous Nerve - A Cadaveric Study for the Feasibility of Procedure and Case Demonstration

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Objective: *To demonstrate the new sensory restoration technique in radial nerve injury using the first branch of dorsal ulnar cutaneous nerve as the donor sensory nerve.*

Material and Method: *Forty formalin-preserved cadavers (18 males and 22 females) were used as the subjects of the present study. The localization of the origin of first branch of dorsal ulnar cutaneous nerve was performed. The measurement was done to determine the origin of this nerve in relation to the tip of ulnar styloid. The simulated transfer was done. The length of the superficial radial nerve that had to be cut was determined. The measurement was done by two observers to determine the reliability of measurement.*

Results: *The mean horizontal distance (X) to the origin of first branch of dorsal ulnar cutaneous nerve measured from the tip of ulnar styloid on the right and left side were 5.22 mm and 6.51 mm respectively. The mean vertical distance (Y) to the origin of first branch of dorsal ulnar cutaneous nerve measured from the tip of ulnar styloid on the right and left side were -7.72 mm and -4.37 mm respectively. The mean length of superficial radial nerve that had to be cut to allow tension free anastomosis, measured from the tip of radial styloid on the right and left side were 68.21 mm and 65.92 mm respectively. The estimated average size of the transferred branch of ulnar cutaneous nerve was about 70% of the size of superficial radial nerve.*

Conclusion: *The sensory restoration in radial nerve injury using sensory nerve transfer from the first branch of dorsal ulnar cutaneous nerve was technically feasible regarding to the comparable size between two nerves and anatomic consistency of the first branch of dorsal ulnar cutaneous nerve.*

Keywords: *Radial nerve palsy, Sensory restoration, Nerve transfer*

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In radial nerve injury, the sensory deficit was the minor problem. The area of deficit was only at dorsoradial aspect of hand and fingers. However, sensory restoration of supplied area may be benefit, especially in the case of combine median and radial nerve injury. Even in the case of pure radial nerve injury, the restoration of dorsoradial sensation was encouraged to improve the quality of life of the patients. The sensation was usually restored by radial nerve repair with or without nerve graft. However, in chronic radial nerve injury or the injury that was not suitable for nerve repair or grafting[1], the nerve transfer could be performed with good result[2]. The author has proposed a new sensory restoration technique by transferring the first branch of dorsal ulnar cutaneous nerve to superficial radial nerve to restore the sensation at dorsoradial aspect of hand. Although the anatomy of dorsal cutaneous branch of ulnar nerve had been studied widely, but the anatomy of the first branch had not been much mentioned[3]. The objective of the present study was to study the anatomy of the first branch of dorsal ulnar cutaneous nerve and the feasibility of this procedure to restore the sensation at dorsoradial side of the hand.

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Material and Method

Forty formalin-preserved cadavers (18 males and 22 females) in the Department of Anatomy, Faculty

of Medicine, Chulalongkorn University were used. Bilateral distal forearms and hands were dissected. The data were collected by two physicians (Sasivongsbhakdi T & Suppaphol S) at different time on each cadaver. The digital Vernier caliper was used for measurement. The ulnarly base rectangular flap was elevated as shown in Fig. 1. The tip of radial and ulnar styloid was identified and pinned. The dorsal ulnar cutaneous nerve was identified. Using the tip of ulnar styloid as the center point, the origin of the first branch of dorsal ulnar cutaneous nerve was identified and pinned. The measurement was done by using the X-axis and Y-axis with the reference point at the tip of ulnar styloid. The direction distally and ulnarly to the tip of ulnar styloid was assigned with positive value, whereas the direction proximally and radially to the tip of ulnar styloid was assigned with negative value. Fig. 2 demonstrates the measurement technique. The first branch of dorsal ulnar cutaneous nerve was cut distally and it was transferred to the dorsal wrist area. The distance from the tip of radial styloid to the planed anastomosis site was estimated. The superficial radial nerve was cut proximally with the estimated length. This length was measured with a digital Vernier caliper. The size of nerves at the anastomosis site was estimated. The discrepancy in size was reported in percentage.

Fig. 1 The formalin preserved cadaveric dissection. The pins were placed at the tip of radial styloid and ulnar styloid.

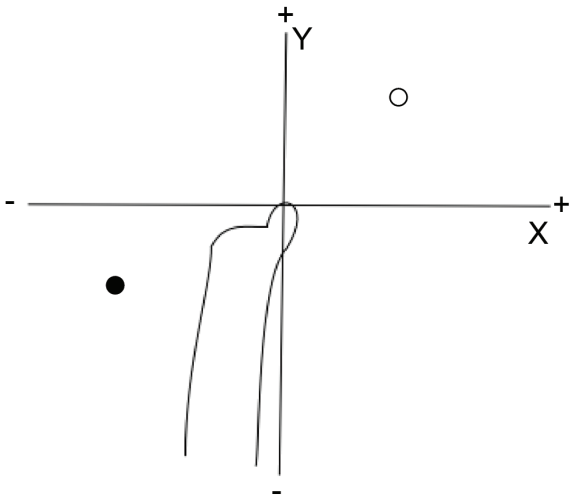

Fig. 2 Demonstration of the measurement axis. The direction ulnarly and distally was assigned with positive value, whereas the direction proximally and radially was assigned with negative value. The white circle had the value of (+,+), whereas the black circle had the value of (-,-).

Surgical technique

The longitudinal incision was made at the radial side of forearm in the predicted course of superficial radial nerve. The distal part of superficial radial nerve was identified and tagged. The separated longitudinal incision was made at the dorsoulnar side of wrist. The dorsal sensory branch of ulnar nerve was identified and protected. The first branch of the dorsal sensory branch of ulnar nerve was identified. This branch would be used as the donor nerve for nerve transfer. The first branch of this nerve was cut distally. The level of cut was determined intraoperatively to obtain the size as large as possible. The distance was measured from the cut end of the first branch of dorsal ulnar cutaneous nerve to the planed anastomosis site, usually about 6 to 7 cm in length[4]. After that, the subcutaneous tunnel was created. Finally, the superficial radial nerve was transferred and anastomosed with the first branch of dorsal ulnar cutaneous nerve.

Ethical consideration

The patient was informed about the risk and benefit of the procedure, including the chance of success or failure of the procedure that could not be known at the present time. The detail of procedure was explained to the patient. The patient had the right to accept or decline the procedure.

Statistical analysis

The means and standard deviation were used to estimate the average length of measurement. The 95% limit of agreement (Bland & Altman, 1986) was used to identify interobserver reliability. The statistical analysis was performed by using STATA program 10.0 (Statacorp, College Station, Texas).

Results

The mean horizontal distance (X) to the origin of first branch of dorsal ulnar cutaneous nerve measured from the tip of ulnar styloid on the right and left side were 5.22 mm and 6.51 mm respectively. The mean vertical distance (Y) to the origin of first branch of dorsal ulnar cutaneous nerve measured from the tip of ulnar styloid on the right and left side were -7.72 mm and -4.37 mm respectively. The mean length of superficial radial nerve that had to be cut to allow tension free anastomosis, measured from the tip of radial styloid on the right and left side were 68.21 mm and 65.92 mm respectively.

The test for interobserver reliability as shown in Table 1 demonstrates a good interobserver reliability of measurement.

Case presentation

A 20-year-old Thai male had the crushing injury to his left forearm. There was laceration of median nerve and segmental loss of superficial radial nerve. The tendon had mild contusion without laceration. The physical examination revealed loss of sensation at the area supplied by median nerve and superficial radial nerve. The median nerve was repaired. The end of the superficial nerve was tagged and plan for grafting later. At three months follow-up, the patient wanted to improve the sensation at the dorsal radial side of hand. He refused to use the nerve graft. Then the surgery was performed using the sensory nerve transfer from first branch of dorsal sensory ulnar nerve to the cut end of the superficial radial nerve as shown in Fig. 3.

Table 1. Interobserver level of agreement (Bland & Altman, 1986)

Variable	Tester 1	Tester 2	Limit of agreement mean (95% CI)
X (right)	5.22±7.54	5.17±7.31	0.05 (-2.32, 2.42)
Y (right)	-7.72±11.80	-7.50±11.67	-0.22 (-3.11, 2.66)
X (left)	6.51±4.88	6.81±5.08	-0.30 (-3.13, 2.53)
Y (left)	-4.37±8.08	-4.39±8.68	-0.03 (-1.87, 1.93)
Right	68.21±13.12	68.51±1.84	-0.29 (-4.74, 4.15)
Left	65.92±14.78	65.66±14.69	0.27 (-3.34, 3.87)

X: Horizontal distance of origin of first branch of dorsal ulnar cutaneous nerve to tip of ulnar styloid.
Y: Vertical distance of origin of first branch of dorsal ulnar cutaneous nerve to tip of ulnar styloid.
Right: The length of superficial radial nerve that had to be cut to allow tension free anastomosis, measured from the tip of radial styloid on the right side.
Left: The length of superficial radial nerve that had to be cut to allow tension free anastomosis, measured from the tip of radial styloid on the left side.
Positive value denote the location at ulnar and distal to the ulnar styloid.
Negative value denote the location at radial and proximal to the ulnar styloid.

Fig. 3 The final transfer was demonstrated. The larger nerve on the left side was the superficial radial nerve. The smaller nerve was the first branch of dorsal ulnar cutaneous nerve.

At six months after the surgery, the sensation at the dorsoradial side of hand had significantly improved. The monofilament test was done and the patient can detect the presence of No. 4.31 monofilament. There was minor donor sensory deficit at the dorsoradial side of ring finger with the size approximately 1.2x0.5 cm.

Discussion

Although the sensory deficit after complete radial nerve injury was negligible, the disability is perhaps bothersome, especially in the combine nerve injury, which the result of nerve repair may not be optimal. Nerve repair had been reported to give good result after sharp cut injury[7]. However, in complete radial nerve palsy or proximal superficial radial nerve injury that the nerve repair was delayed or impossible, the sensory restoration can be performed to improve the quality of life. The reconstruction should restore the sensation at dorsoradial side of hand with little morbidity to the donor's nerve supplied area. The author has proposed the sensory restoration technique using the first branch of dorsal ulnar cutaneous nerve transferred to the superficial radial nerve. The reasons

for selection of this nerve were: 1) This nerve usually supplies the small area at the dorsoradial aspect of ring finger, and the donor site morbidity is negligible, 2) This procedure imitates the normal variation of the communication between superficial radial nerve and dorsal ulnar cutaneous nerve that has been reported in 40 to 60% of normal population[6,7].

The author has proposed the indications for this procedure as follow: 1) Chronic radial nerve injury longer than 6 to 12 months whose result of nerve repair or grafting was poor. The tendon transfer can be performed, together with this procedure. 2) Irreparable superficial radial nerve injury in which there was adequate length of distal stump of superficial radial nerve, at least 6 to 7 cm in length, and 3) Combined median and radial nerve injury whose primary repair of superficial radial nerve could not be performed. However, even in the cases with radial nerve palsy, the sensation at the dorsoradial aspect of hand should be evaluated first, because the sensation of this area can be intact in some patients. This can be explained by the variation of communications between superficial radial nerve and dorsal cutaneous branch of ulnar nerve[4,6-9]. The drawback of this procedure was the alteration of sensory pattern after successful nerve transfer. The area of sensation felt by the patients would be lost at the dorsoradial aspect of ring finger. However, in the end, the patients can be adapted and get accustomed to it.

Conclusion

Although the sensory deficit in chronic radial nerve injury was negligible, the sensory restoration by transferring the first branch of dorsal ulnar cutaneous nerve was encouraged to regain the sensation at dorsoradial side of hand. This technique was feasible regarding to the comparable size between two nerves and anatomic consistency of the first branch of dorsal ulnar cutaneous nerve.

What is already known on this topic?

The sensory restoration after chronic radial nerve injury was considered unnecessary for protective hand function. However, if the sensory restoration can be done, the quality of life of patients would be better.

There was no report using the first branch of dorsal ulnar cutaneous nerve as the donor nerve for sensory restoration in this area.

What this study adds?

The sensory restoration after chronic radial nerve injury was technically feasible. The sensory restoration after the operation was quite good with little donor site morbidity.

Acknowledgement

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Potential conflicts of interest

None.

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การฟื้นฟูความรู้สึกในผู้ป่วยที่ได้รับการบาดเจ็บของเส้นประสาทเรเดียลโดยใช้แขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่า โดยศึกษาจากศพเพื่อแสดงถึงความเป็นไปได้ในการผ่าตัดและสาธิตตัวอย่างผู้ป่วย

สรศักดิ์ ศุภผล, อิทธิรัตน์ วัชรานานันท์, ตุลยพฤกษ์ ถาวรสวัสดิ์รักษ์, ภัทรวัณย์ วรธนารัตน์, ธนเนตร์ ศศิวงศ์ภักดี, วิโรจน์ กวินวงศ์โกวิท

วัตถุประสงค์: *เพื่อสาธิตวิธีการผ่าตัดแบบใหม่ในการฟื้นฟูสภาพความรู้สึกในผู้ป่วยที่ได้รับการบาดเจ็บของเส้นประสาทเรเดียล โดยการย้ายเส้นประสาทจากแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่า ไปยังแขนงของเส้นประสาทเรเดียล*

วัสดุและวิธีการ: *การศึกษานี้เป็นการศึกษาทางกายวิภาคของแขนงเส้นประสาทเรเดียลและแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่า โดยศึกษาจากศพจำนวนทั้งสิ้น 40 ราย แบ่งเป็นผู้ชาย 18 ราย และผู้หญิง 22 ราย โดยหาตำแหน่งจุดแตกแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่าซึ่งจะสัมพันธ์กับตำแหน่งของจุดปลายของกระดูกอัลน่าสไตรอยด์ โดยได้ทำการจำลองการผ่าตัดย้ายเส้นประสาทดังกล่าว เพื่อศึกษาความเป็นไปได้ในการผ่าตัดจริง และการวัดกระทำโดยผู้สังเกตการณ์ 2 คน โดยมีการศึกษาความน่าเชื่อถือของการวัดระหว่างบุคคล*

ผลการศึกษา: *ระยะทางแนวนอนเฉลี่ยวัดจากจุดปลายของกระดูกอัลน่าสไตรอยด์ไปยังจุดแตกแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่าข้างขวาและซ้ายคือ 5.22 มม. และ 6.51 มม. ตามลำดับ และระยะทางแนวดิ่งเฉลี่ยวัดจากจุดปลายของกระดูกอัลน่าสไตรอยด์ไปยังจุดแตกแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่าข้างขวาและซ้ายคือ -7.72 มม. และ -4.37 มม. ตามลำดับ ส่วนความยาวเฉลี่ยของแขนงเส้นประสาทเรเดียลที่ต้องตัดแล้วย้ายมาต่อกับแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่าโดยปราศจากความตึงของข้างขวาและซ้ายคือ 68.21 มม. และ 65.92 มม. ตามลำดับ และขนาดเฉลี่ยโดยประมาณของแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่ามีขนาดใหญ่ประมาณร้อยละ 70 ของขนาดของแขนงเส้นประสาทเรเดียล ณ จุดต่อของเส้นประสาทดังกล่าว*

สรุป: *การผ่าตัดเพื่อฟื้นฟูสภาพความรู้สึกบริเวณหลังมือของผู้ป่วยที่ได้รับบาดเจ็บของเส้นประสาทเรเดียล มีความเป็นไปได้ที่จะถูกแก้ไขโดยวิธีดังกล่าวได้ เนื่องจากขนาดที่ใกล้เคียงกันของเส้นประสาทดังกล่าว และความแน่นอนทางกายวิภาคของแขนงแรกของเส้นประสาทรับความรู้สึกของเส้นประสาทอัลน่า*