Efficacy of supraclavicular anterior scalenotomy and brachial plexus neurolysis without rib resection for post-traumatic neurogenic thoracic outlet syndrome

Tetsuya Yoshizumi, MDPhD, Hiroshi Kanno, MDPhD,
Masamichi Shinonaga, MDPhD,

Department of Neurosurgery,
International University of Health and Welfare Atami Hospital,
Atami, Japan
Disclosure statement

We disclose no relation to any private or official companies and any government organizations at the time of the abstract submission.
Background

Neurogenic thoracic outlet syndrome (NTOS) comprises over 95% of all TOS patients. The etiology most often is a neck trauma, most commonly an auto accident.

Our aim is to evaluate the outcomes of patients who underwent anterior scalenotomy without rib resection for post-traumatic NTOS.
◆ Methods

96 cases (76 patients) of post-traumatic NTOS who underwent supraclavicular anterior scalenotomy and brachial plexus neurolysis without rib resection from September 2014 to December 2019 were reviewed using medical record and operative notes.

◆ Assessment of clinical outcome

1. Short-term outcome: 2 months after surgery

2. Long-term outcome: 12 months later (outcome at the last clinic follow-up appointment)

◆ Clinical outcome

Below 4 grades of patients subjective evaluation after surgery were used.

- Excellent: complete relief of symptoms
- Good: relief of most major symptoms
- Fair: relief of some symptoms, but persistence of other symptoms
- Poor: no improvement

Excellent, Good, and Fair were defined as a successful outcome.

◆ Diagnosis of Post-traumatic NTOS

1. A history of trauma
2. Symptomatic presentation
3. Physical examination maneuvers including Morley test
4. Exclusion of any cervical cord lesions by cervical MRI, CT and any other peripheral nerve disturbance of upper extremity
5. Botox block of the anterior scalene muscle for symptomatic relief

All surgical therapies performed only when clinical symptoms hadn’t improved following at least 3 months of conservative therapy.

◆ Supracravicular anterior scalenotomy and brachial plexus neurolysis without rib resection

1. Skin incision
2. Separation of Sternocleidomastoid M.
3. Exposure of anterior scalene M.
4. Anterior scalenotomy
5. After anterior scalenotomy
**Demographics and Characteristics**

Between September 2014 and December 2019, a total of 75 post-traumatic NTOS patients underwent 96 supraclavicular scalenotomy and brachial plexus neurolysis without rib resection.

**Age**
- Median: 44 years
- Range: 20-76 years

**Sex**
- Male/Female: 17/79

**Preop Duration after Trauma**
- Median: 79 months
- Range: 4-348 months

**Distribution of trauma patients experienced**
- Motor vehicle accident: 83 (89.3%)
- Bruise: 4 (4.2%)
- Fall: 3 (3.1%)
- Slip: 2 (2.1%)
- Domestic violence: 2 (2.1%)

**Presenting Complaint**
- Pain: 96 (100%)
- Motor deficit: 83 (86.4%)
- Paresthesia: 82 (85.1%)

**Morley test positive**
- 93 (96.9%)

**Right side surgery**
- 47 (49.0%)

**Follow up Duration after Surgery**
- Median: 33 months
- Range: 2-64 months

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**Operative findings (96 cases)**

- Fibrous band within anterior scalene muscle: 89.6%
- Adhesion between the brachial plexus and anterior scalene muscle: 88.5%
- Hypertrophied anterior scalene muscle: 59.4%
- Trunks passing through within anterior scalene muscle: 8.3%
- Requirement of partial middle scalenotomy: 5.2%

Any bony structures weren’t required to be removed in all cases.
Operative findings

Result

Fibrous band within anterior scalene M.

Intraoperative finding

Pathological finding

Upper trunk passes through in anterior scalene muscle.

Result

Anterior scalene M.

Upper trunk

Phrenic nerve

Anterior scalene M.

Middle trunk

Lower trunk

This picture shows hard adhesion between anterior scalene muscle and lower trunk, and fibrousis of paraneurium arround lower trunk.
Outcome

- The median follow-up duration: 33 months (2-64)

- **85 cases** (88.5%) could be followed up for more than 12 months after surgery.
The median follow-up duration of cases followed up for more than 12 months: 33 months (12-64)

- There was no intra- and post-operative complication.

Outcome at 2 months (96 cases)

Success rate (excellent+good+fair) as short-term outcome was **99.0%**

Outcome at more than 12 months later (85 cases)

- 15 (17.6%) of 85 cases who were followed up more than 12 months had a relapse of symptoms after transient improvement at 2 months.
- In 6 of the 15 cases, re-operations were performed in median 34.5 months (26-48 months) after the first operation.

Success rate (excellent+good+fair) as long-term outcome was **82.4%**

Reoperative findings

- Strong adhesion between trunks and any adjacent tissues: 6 (100%)
- Compression of plexus by a flared middle scalene muscle: 6 (100%)
- Compression of plexus by remaining anterior scalene muscle by incomplete scalenotomy: 1 (16.7%)
Success rate

- Short-term outcome at 2 months after surgery was very favorable (Success rate: 99%).
- Sanders’s review (Sanders et al; The Neurologist. 2008)

Success rate from previous studies,
- Transaxillary First Rib Resection: 45-92% from 9 series
- Supraclavicular First Rib Resection and Scalenectomy: 64-86% from 7 series
- Supraclavicular Scalenectomy: 63-80% from 5 series

These outcomes are similar with our result (success rate at more than 12 months follow-up: 82.4%) about supraclavicular anterior scalenotomy and neurolysis without rib resection.

Complications

- There was no intra-and post-operative complications like injuries of any vessels, phrenic nerve, brachial plexus, and wound infection in this study.
- Numerous complications of first rib resection have ever been reported (Cherleton et al; 1986), (Dale et al, 1982).
- Meliire et al found that incidence of complications is low, but when they do occur they can lead to disabling sequelae or even death (Meliire et al. 1991)
- Rib resection is associated with longer surgical times and hospital stays (Maqbool et al; 2018).

Supraclavicular scalenotomy and neurolysis without rib resection is able to be performed more safely and easily.
Problem of this procedure

- Recurrence rate in this study at 12 months later: 17.6%
- Operative findings of 6 cases who underwent re-operation:
  1. adhesion between trunks and scar tissue
  2. Compression of plexus by flaired middle scalene muscle
  3. Remaining anterior scalene muscle with incomplete scalenotomy

Prevention and prediction of re-adhesion at the first surgery is very difficult. Recently, Sanders et al reported wrapping of the brachial plexus with amnion membrane prevents postoperative adhesions (Sanders et al; J Vasc Surg Cases Innov Tech. 2018)

The necessity of aditional partial middle scalenotomy needs to be considered at first surgery.

Mechanism of Post-traumatic NTOS
(Sanders et al; The Neurologist. 2008) (Crotti et al; Acta Neurochir. 2005)

1. Trauma (auto accident etc)

2. Intrascalene muscles hemorrhage and swelling as a result of a hyper-extension neck injury

3. Scar tissue formation within the muscle and around the nerves following the blood absorbed

Pressure on the brachial plexus

In post-traumatic NTOS, the brachial trunk can be mainly compressed or entrapped in the scalene triangle between the anterior and middle scalene muscles?

On the basis of this mechanism, Supraclavicular scalenotomy and neurolysis for Post-traumatic NTOS makes sense, and rib resection are not required.
Conclusion

Supraclavicular scalenotomy and neurolysis without rib resection for post-traumatic NTOS is able to be performed very easily and safely, effective, and makes sense considering the etiology.