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Transaxillary First Rib Resection for Treatment of the Thoracic Outlet Syndrome. --Manuscript Draft--

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TITLE:**Transaxillary First Rib Resection for Treatment of the Thoracic Outlet Syndrome****AUTHORS:**Murat Akkuş^{1*}, Selçuk Köse², Yaşar Sönmezoğlu³¹Department of Thoracic Surgery, Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, Kucukcekmece Istanbul, Turkey²Department of Thoracic Surgery, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey³Department of Thoracic Surgery, Yedikule Chest Disease and Thoracic Surgery Training and Research Hospital, Zeytinburnu, Istanbul, Turkeyakkusmdr@gmail.comselcukko@yahoo.comyasarsonmezoglu@yahoo.com**CORRESPONDING AUTHOR:**

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KEYWORDS:

Brachial Plexus, Surgical Technique, Thoracic outlet syndrome, Thoracic Surgery, Transaxillary First Rib Resection Technique, Videothoracoscopy.

SUMMARY

Here, we present a protocol of the transaxillary resection of the first rib for treatment of thoracic outlet syndrome caused by compression of the brachial plexus, subclavian vein and artery.

ABSTRACT

Thoracic outlet syndrome (TOS) is a common disorder that causes a significant loss of productivity. The transaxillary first rib resection (TFRR) protocol has been used for the decompression of trapped neurovascular structures in the TOS. Among the other surgical procedures, the advantage of the TFRR is that it has the smallest rate of recurrence and better cosmetic outcomes. The disadvantage of TFRR is that it provides a narrow, and deep working corridor that makes obtaining vascular control challenging.

INTRODUCTION

The compression of the brachial plexus, subclavian artery or vein in the scalene triangle is clinically known as thoracic outlet syndrome (TOS), first described by Peet et al.¹. Thoracic outlet syndrome is subdivided into neurogenic (NTOS), arterial TOS, and venous TOS based on the underlying etiology¹. Patients with NTOS (93-95% of TOS cases) present with pain, numbness, and ipsilateral weakness. Patients with venous TOS (3-5%) present with venous thrombosis, and patients with arterial TOS (1-2%) present with arterial thromboembolic event and ischemia. Conservative management of TOS includes medications and physiotherapy and is the first choice for TOS cases. The surgical treatment modalities include decompression procedures and are performed after conservative management has failed². Decompression techniques include the transaxillary first rib resection (TFRR), supraclavicular first rib resection scalenectomy (SFRRS), scalenectomy (without first rib resection via supraclavicular or transaxillary), and posterior approach first rib resection (PA-FRR)³. The transaxillary first rib resection, a technique described by Roos et al. in 1966, is an effective method for treatment

of TOS^{4,5}. The main goal of TFRR is to completely remove the last cervical and first thoracic ribs and to decompress the underlying neurovascular bundle.

Vascular TOS (VTOS) are diagnosed with CT angiography, color duplex USG, and arteriography or venography, whereas the NTOS is diagnosed with X-ray, electrodiagnostic studies (needle electromyography), color duplex Doppler USG, and cervical MRI. Physiotherapist and psychiatrist consultations should be obtained to exclude other disorders preoperatively. The symptom relief with lidocaine injection to the anterior scalene muscle is also a good indicator for diagnosis and predictor of surgical benefit in NTOS patients⁶.

PROTOCOL:

This study was conducted in accordance with Declaration of Helsinki and local clinical ethics committee (2018/09).

1. Physical Examination

NOTE: The provocative tests for diagnosis of the TOS are depicted in **Figure 1**.

1.1. For the Adson test (scalene test, **Figure 1A**), bring the patient's shoulder to external rotation with slight abduction and a little bit of extension and palpate the radial pulse. Extend the patient's head backward and rotate toward the tested shoulder. Ask the patient to breathe in and hold their breath.

1.1.1. Consider the test positive in cases where reproduction of symptoms or abolition of the radial pulse occurs while symptoms resolve with rotating of the head to the contralateral side.

1.2. For the costoclavicular brace test (**Figure 1B**), bring the patient's arm to the back, depress and retract over the patients' scapula on the ipsilateral side. Check the pulse. If the radial pulse disappears or symptoms are reproduced, the test is deemed positive.

1.3. For the hyperabduction test (**Figure 1C**), slightly extend the patient's arm and palpate the radial artery. Abduct the arm 90-180°. A positive test is a decrease in the pulse of the radial artery from baseline to the new position.

1.4. For the Roos (East) test (**Figure 1D**), perform the test in either a sitting or standing position. Take the patient's shoulders to 90° abduction, externally rotate, and flex elbows to 90°. The elbows should be slightly behind the frontal plane. Have the patient open and close his/her hands for 3 minutes.

1.4.1. Consider the test positive if the patient experiences heaviness, ischemic pain or weakness of the arms or numbness and tingling of the hands. Discoloration of the hands is also meaningful for the test.

NOTE: Surgical treatment is the first option in VTOS cases, whereas surgical treatment is performed in NTOS cases after 3 months of conservative therapy without any improvement in their daily life, work life, and sleep quality.

2. Preoperative clinical and electrodiagnostic assessment

2.1. For evaluation of the clinical improvement with surgical treatment, make clinical findings in the physical examination, EMG findings, and the QuickDASH (Disability of Arm, Shoulder, and Hand: <http://www.dash.iwh.on.ca/about-quickdash>) questionnaire related to symptoms of daily activities and social and psychological preoperative periods.

2.2. Determine the preoperative EMGs by measuring the compound motor action potential (CMAP), sensory nerve action potential (SNAP), and nerve conduction velocity (NCV) and F-wave latency. Make recordings using a commercial EMG/NCV/EP measuring system (e.g., Nihon Kohden Neuropack 2).

3. Transaxillary first rib resection in a stepwise manner

3.1. Perform anesthesia using a standard anesthetic induction protocol which includes 0.6 mg/kg rocuronium bromide, 0.05 mg/kg midazolam and 1-2 µg/kg fentanyl.

3.2. Administer tiopental sodium at 6 mg/kg for maintenance.

4. Patient position (Figure 2)

4.1. After placing the patient in the lateral decubitus position, wrap the arm, elevate and hang in a 90° abduction position. If needed, reduce traction every 3-5 minutes to prevent postoperative complication.

4.2. Use a solution of 10% sterile povidone-iodine for topical sterilization. Drape the arm, axilla and chest. Use sterile sheets on to rest of the body to prevent contamination.

5. Reaching the first rib

5.1. Use the surgical instruments are shown in **Figure 3** and the **Table of Materials**.

5.2. Make an incision in a transverse fashion below the axillary hairline extending from the pectoralis muscle anteriorly and the latissimus dorsi muscle posteriorly at a length of 5-7 cm.

5.3. Cross the skin, subcutaneous tissue, and fascia to reach the anterior chest wall.

5.4. Use blunt dissection to reach the first rib.

6. Releasing the first rib from muscles and fascia

6.1. Pierce the fascia overlying the first rib and dissect away the periosteum overlying the superior part of the rib. Bluntly dissect the inferior edge of the rib from surrounding muscles using monopolar cautery and rib raspatory.

6.2. Split the intercostal muscles until the costoclavicular ligament at the sternocostal junction and the angular costa in the posterior costovertebral junction.

6.3. In the superior edge of the first rib, expose the anterior scalene muscle anteriorly and medius scalene muscle posteriorly. Place the curved forceps under the anterior and middle scalene muscles to cut the muscles at the level of their insertion over the first rib, where they are farthest from the phrenic nerve.

7. Removal of the first rib or the cervical rib

7.1. Start the resection of the first rib at the sternocostal junction anteriorly. First, turn from its superior edge and then the inferior edge to resect it using a rib cutter from the sternum. Ensure that the neurovascular structures are preserved.

7.2. Afterwards, resect the posterior portion of the rib, and disarticulate the part located distally to the angle of rib; hence complete the rib resection.

7.3. After totally freeing the cervical rib from surrounding tissue, resect and disarticulate the rib until the articular surface of the transverse process is seen.

8. Postoperative Period

8.1. In postoperative period, perform a chest X-ray to rule out complications, such as pneumothorax.

8.2. Remove the thorax drain on postoperative day 1 in uneventful cases.

8.3. Use nonsteroidal anti-inflammatory drugs, narcotic analgesics, and a muscle relaxant for postoperative pain.

8.4. In the early postoperative period, examine movement of the arm in the operated side. Continue physical therapy for the first two post-operative months.

8.5. Advise the patient not to perform any exhausting activity with the operated side.

9. Postoperative clinical and electrodiagnostic assessment

9.1. For evaluation of the clinical improvement with surgical treatment, compare clinical findings in the physical examination, EMG findings, and the QuickDASH (Disability of Arm, Shoulder, and Hand: <http://www.dash.iwh.on.ca/about-quickdash>) questionnaire related to symptoms of daily activities and social and psychological preoperative and postoperative (3 months) periods.

9.2. Compare the preoperative and postoperative EMGs by measuring the compound motor action potential (CMAP), sensory nerve action potential (SNAP), and nerve conduction velocity (NCV) and F-wave latency. Make recordings using a commercial EMG/NCV/EP measuring system (e.g., Nihon Kohden Neuropack 2).

9.3. Perform the physical examination postoperatively to evaluate the pain and paresthesia.

REPRESENTATIVE RESULTS:

Clinical Outcomes

A total of 15 patients were included in this study. Three patients (20%) were male and 12 patients (80%) were female. The mean age of patients was 30.6 ± 8.98 years. All male participants and 5 of female participants were manual laborers. The most common complaint of the NTOS group was arm-forearm pain and numbness weakness of grip and hypothenar atrophy. In the postoperative clinical follow-up, patients were questioned about their

paresthesia and pain severity, overall satisfaction, their activity and work status. QuickDASH scores and EMG value were evaluated preoperatively and in the postoperative period. Comparison of preoperative and postoperative EMG measurements are presented in **Table 1**, **Table 2**, **Figure 4**, **Figure 5** and **Figure 6**. We found a remarkable clinical improvement between preop- and postoperative QuickDASH⁷.

The postoperative exam at six months was evaluated for recurrence or surgical failure. The recurrence rate has been noted to be between 6-54% in different case series⁸. In the study here, recurrence was observed in 6% of patients (n=1) at the operative side after six months of operation while 20% of patients (n=3) reported TOS symptoms at the contralateral side in follow-up (4 to 12 years).

All patients were discharged between postoperative days 2-5. The morbidity rates have been noted to be between 5-40% and include pneumothorax, infection, nerve injury (long thoracic nerve, cervical sympathetic chain, roots of the brachial plexus), hemothorax, hematoma in the surgical field, and lymphatic fluid leakage. These complications are often temporary and resolve within a few days. Deficits lasting longer may require surgical intervention.

Electrodiagnostic outcomes

The latency of the median F-wave was remarkably prolonged on the affected side compared to the unaffected side preoperatively. There was no significant difference in the latency of ulnar F-waves between sides. Compound motor action potential (medial antebrachial cutaneous), sensory nerve action potential (ulnar), and nerve conduction velocity (median motor amplitude) values increased significantly postoperatively. EMG findings are correlated with postoperative clinical improvement⁷.

FIGURE AND TABLE LEGENDS

Figure 1. Provocative tests for thoracic outlet syndrome. (A) The Adson test. (B) The Costoclavicular brace test. (C) Hyperabduction test. (D) Roos (East test).

Figure 2. Operative position used for patient positioning.

Figure 3. Surgical instruments used for the procedure.

Figure 4. Comparison of preoperative and postoperative values of the medial antebrachial cutaneous (MAC) nerve action potentials on each patient. Blue: preoperative data; Red: postoperative data.

Figure 5. Comparison of preoperative and postoperative values of the ulnar nerve sensory responses on each patient. Blue: preoperative data; Red: postoperative data.

Figure 6. Comparison of preoperative and postoperative values of the median motor actions amplitude responses on each patient. Blue: preoperative data; Red: postoperative data.

Table 1. Comparison of the median nerve F response and ulnar nerve F response of upper extremities preoperatively.

Table 2. Preoperative and postoperative comparisons of the electrophysiological measures.

Video. Transaxillary first rib resection in a stepwise manner.

DISCUSSION

TFRR is the most used surgical technique for treatment of TOS⁹⁻¹¹. The advantage of the TFRR is that it provides a better cosmetic result with a hidden incision in the axilla without requirement of cutting the muscles to reach the surgical field. Its disadvantage is the relatively narrow and deep working space. The supraclavicular approach, which is preferred for arterial TOS treatment, puts the subclavian artery at less risk of damage¹². The subclavian vein is followed in the infraclavicular approach commonly used for venous TOS treatment, and the posterolateral FRR is mostly used for the treatment of the recurrent TOS^{13,14}.

A randomized study of the supraclavicular neoplasty of the brachial plexus by Sheeth et al. noted that TFRR provides a better surgical outcome than other surgical techniques¹⁵. Another study compared the NTOS cases treated with TFRR, the cases treated with the supraclavicular FRR+scalenectionomy, and the cases treated only with scalenectionomy, which resulted in clinical improvement rates of 60-92%, 64-86%, and 63-80%, respectively. Although there has not been a significant difference between surgical outcome, lower recurrence rates have been noted in cases treated with TFRR^{10,16-19}.

The retractor should be used carefully and in an anterior-posterior direction to avoid damage to the neurovascular structures in the narrow field. The scalene triangle has anterior and middle scalene muscles on both side and has the first rib in its basal side. The subclavian artery and brachial plexus passes through the scalene triangle, and scalene vein passes anterior to the anterior scalene muscle, not through the scalene triangle. The first rib is retracted downward, and the middle scalene muscle is cut at its attachment point to the first rib. After the anterior and middle scalene muscles are cut, the fascia and soft tissues along the superior edge of the first rib are freed from the sternum anteriorly to the vertebral body posteriorly. Although not required for this illustrative case, anterior costoclavicular ligament and subclavian muscle division might be needed in some cases. The retraction should be avoided toward the apex of the scalene triangle, where neurovascular structures reside. Intraoperative nerve injury may cause severe disabilities, such as the diaphragm eventration caused by the phrenic nerve injury, winging of the scapula caused by the long thoracic nerve injury, and numbness in the arm caused by the intercostobrachial nerve injury. The inferior edge of the first rib is freed from pleura gently. In case of unintended pleura opening, a chest tube should be placed to prevent the hemothorax or pneumothorax. Since the most common cause of recurrence is leaving a piece of the posterior part of the rib, the first rib should be completely removed. During this procedure, especially posteriorly, there is a risk of injury to the intercostal vein. Oozing from the intercostal veins is stopped by tamponade rather than using the electrocautery, which may damage the brachial plexus causing postoperative causalgia.

Since the surgical corridor in TFRR technique is narrow, hemostasis is crucial to make the working area clean and to prevent postoperative hematoma. During the closure, a hemovac drain can be placed.

In conclusion among surgical treatment modalities used for cases of TOS, the TFRR technique is a unique modality with excellent surgical outcomes and lower recurrence rates. The major limitation of this procedure is that it provides restricted vascular reconstruction options in VTOS cases.

DISCLOSURES:

None

ACKNOWLEDGMENTS:

None

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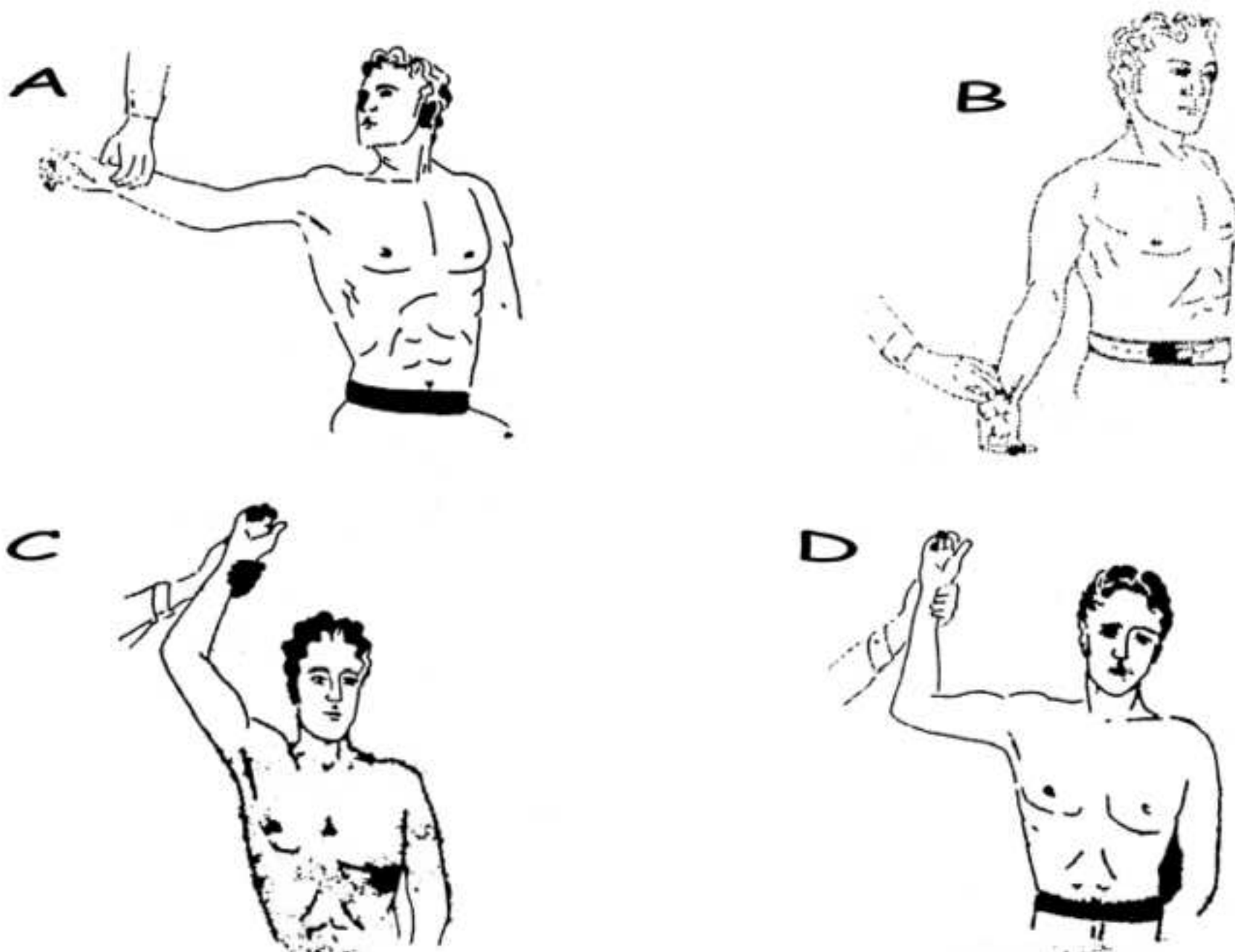




Figure 3. Surgical instruments

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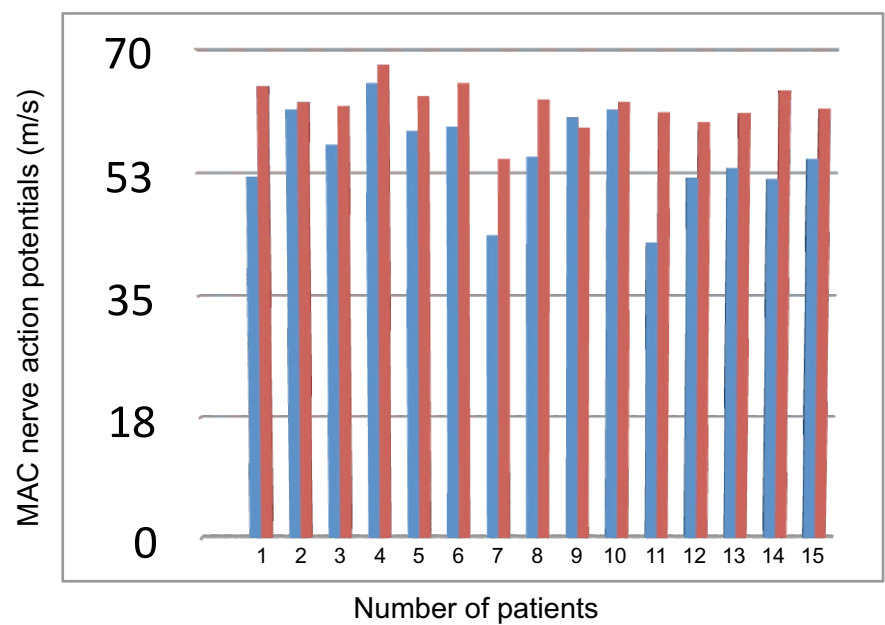
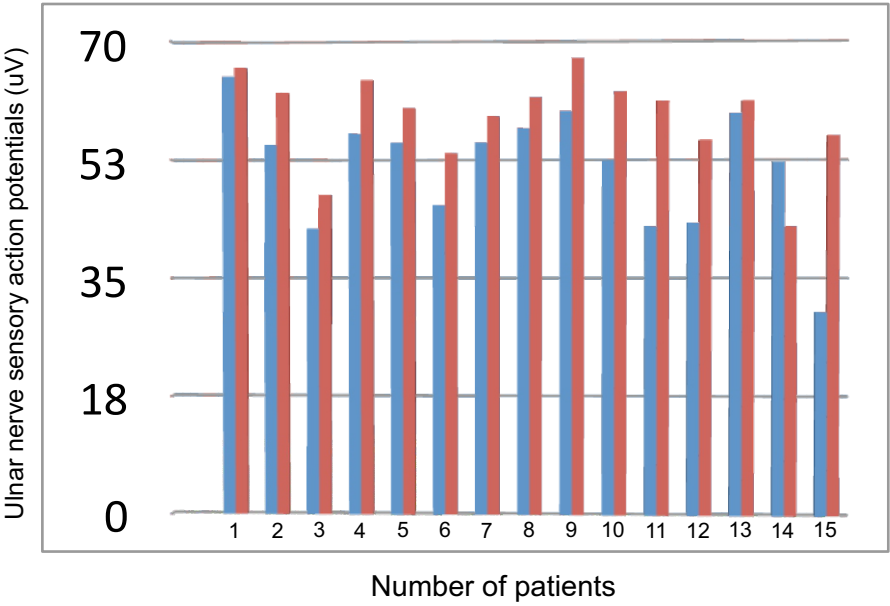
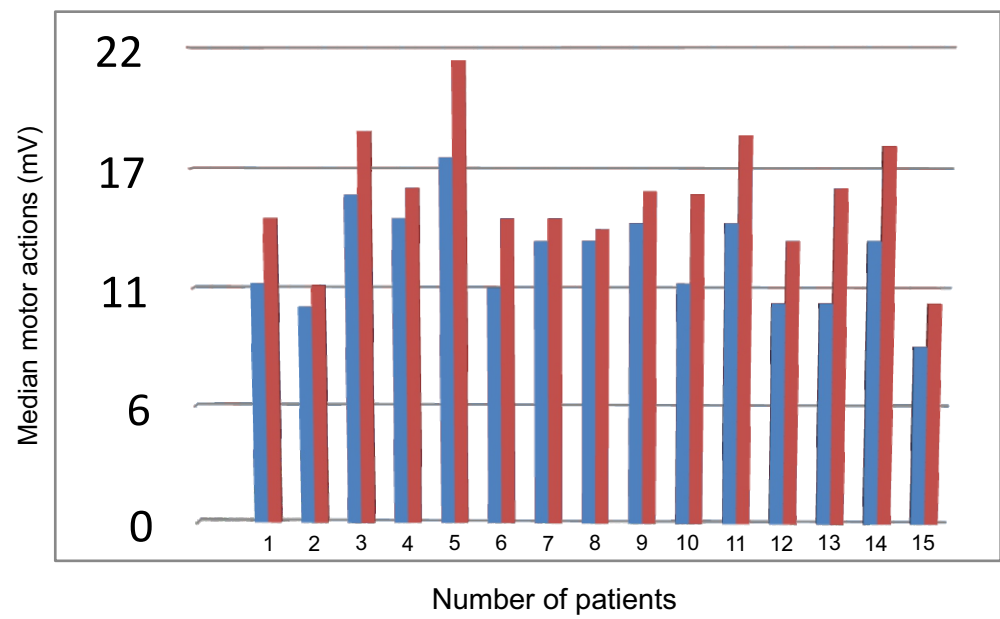



Figure 5







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Table 1. Comparison of the median nerve F response and ulnar nerve F response of the both upper extremities preoperatively.

	Unaffected Side	Affected Side	p value
Median F Response(ms)	22.94±1.79	23.98±2.05	0.015
Ulnar F Response(ms)	23.57±1.97	24.01±2.49	0.246

This table has been modified from [7].

Table 2. Preoperative and postoperative comparisons of the electrophysiological measures

	Preoperative	Postoperative	p value
MAC(m/s)	55.1 ± 6.36	62.15 ± 3.08	0.0001
U-SNAP (μV)	51.35 ± 8.95	58.66 ± 6.8	0.003
MMA(mV)	12.43 ± 2.32	15.2 ± 2.82	0.0001

MAC: medial antebrachial cutaneous, U-SNAP: ulnar sensory neural action potential,
MMA: median motor amplitude
This table has been modified from [7].

Name of Material/ Equipment	Company	Catalog Number	Comments/Description
Ag Debakey vascular forceps 24 cm, 3.5 mm	Lawton medizintechnik	30-0032	Check the hemorrhage
Bone chisels curved 13x9.1/2"	Aesculap Inc.	MB-992R	Dissect the periosteum of the first rib
Doyen-stille retractor 24 cm	Lawton medizintechnik	20-0650	Skin- muscle retraction
Foerster sponge forceps straight	Lawton medizintechnik	07-0156	For swabbing
Luer stille bone rongeur curved 27 cm	Lawton medizintechnik	38-0703	Bone punches
Luer stille rongeur straight 22 cm	Lawton medizintechnik	38-0400	Rib cutter
Mayo hegar needle holder 20.5 cm	Lawton medizintechnik	08-0184	Suturing
Metzenbaum scissors curved delicate 23 cm	Lawton medizintechnik	05-0665	Dissection
Overholt curved forceps delicate 30.5 cm	Lawton medizintechnik	06-0807	Split the scalen muscles from the rib
Roberts art forceps straight 24 cm	Lawton medizintechnik	06-0370	For sponge and remove remain bone
Roux retractor medium size 15.5 cm	Lawton medizintechnik	20-0402	Wound retraction
Semb rasparotry 22,5 cm, 12mm	Lawton medizintechnik	39-0252	Dissect the muscle of the first rib
Smith peterson model curved osteotome 13x205 mm	Lawton medizintechnik	46-0783	Dissect the muscle of the first rib
Stille -giertz rib shears 27 cm	Lawton medizintechnik	38-0200	First rib cutting
Stille osteotome 8x205 mm	Lawton medizintechnik	46-0248	Dissect the periosteum of the first rib
Wagner rongeur 5.5x210 mm	Lawton medizintechnik	53-0703	Punches

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Date: May 28, 2019
To: "Murat Akkuş" akkusmdr@gmail.com
cc: "Selcuk Kose" selcukko@yahoo.com, "Yaşar Sönmezoğlu" yasaronmezoglu@yahoo.com
From: "Xiaoyan Cao" xiaoyan.cao@jove.com
Subject: Revisions required for your JoVE submission JoVE59659R1

Dear Dr. Akkuş,

Your manuscript, JoVE59659R1 "Transaxillary First Rib Resection Technique for Treatment of the Thoracic Outlet Syndrome. How to do it!," has been editorially and peer reviewed, and the following comments need to be addressed. Note that editorial comments address both requirements for video production and formatting of the article for publication. Please track the changes within the manuscript to identify all of the edits.

After revising and uploading your submission, please also upload a separate rebuttal document that addresses each of the editorial and peer review comments individually. Please submit each figure as a vector image file to ensure high resolution throughout production: (.svg, .eps, .ai). If submitting as a .tif or .psd, please ensure that the image is 1920 x 1080 pixels or 300 dpi. Additionally, please upload tables as .xlsx files.

Your revision is due by **Jun 11, 2019**.

To submit a revision, go to the [JoVE submission site](#) and log in as an author. You will find your submission under the heading "Submission Needing Revision". Please note that the corresponding author in Editorial Manager refers to the point of contact during the review and production of the video article.

Best,

Xiaoyan Cao, Ph.D.
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Answer: Permission document has been submitted as a separate file in submission system.

3. Please revise lines 154-157 and 170-172 to avoid textual overlap with previously published work.

Answer: Lines 154-157 and 170-172 have been revised.

4. Title: Please remove colloquial phrases (How to do it!).

Answer: Title has been revised and colloquial phrases have been removed.

5. Authors and affiliations: Please provide an email address for each author.

Answer: E-mail addresses of each author have been included.

6. Introduction: Please rephrase to include a clear statement of the overall goal of this method.

Answer: A clear statement of the overall goal of this method has been included in introduction section.

7. All methods that involve the use of human or vertebrate subjects and/or tissue sampling must include an ethics statement. Please provide an ethics statement at the beginning of the protocol section indicating that the protocol follows the guidelines of your institution.

Answer: Ethics statement has been provided in protocol section.

8. Please revise the Protocol to contain only action items that direct the reader to do something (e.g., "Do this," "Ensure that," etc.). The actions should be described in the imperative tense in complete sentences wherever possible. Avoid usage of phrases such as "could be," "should be," and "would be" throughout the Protocol. Any text that cannot be written in the imperative tense may be added as a "NOTE." Please include all safety procedures and use of hoods, etc. However, notes should be used sparingly and actions should be described in the imperative tense wherever possible.

Answer: Protocol has been revised in accordance with reviewer's comments, imperative tense has been used where appropriate.

9. The Protocol should be made up almost entirely of discrete steps without large paragraphs. Please simplify the Protocol so that individual steps contain only 2-3 actions per step and a maximum of 4 sentences per step. Use sub-steps as necessary.

Answer: The protocol has been simplified.

10. Please add more details to your protocol steps. There should be enough detail in each step to supplement the actions seen in the video so that viewers can easily replicate the protocol. Please ensure you answer the "how" question, i.e., how is the step performed? Alternatively, add references to published material specifying how to perform the protocol action. For instance, specify all surgical tools used throughout the protocol. Please mention how patients are anesthetized and how proper anesthetization is confirmed. Please mention how to maintain sterile conditions during surgery.

Answer: Surgical tools have been identified by a picture presentation while anesthesia protocol and sterile conditions maintenance have been explained in protocol steps.

11. JoVE article does not have a Conclusion section. Please move information in the Conclusion section to Results or Discussion (as appropriate).

Answer: Conclusion section has been changed to Discussion section.

12. Tables 3-5: Please upload these tables individually as figures to your Editorial Manager account as a .png, .tiff, .pdf, .svg, .eps, .psd, or .ai file. Please label the x-axis in each table/figure.

Answer: Table 3-5 formats have been changed to pdf.

13. Table 1 and Table 2: Please upload each Table individually to your Editorial Manager account as an .xlsx file. Avoid any coloring or formatting in the tables.

Answer: Table 1-2 formats have been changed to .xlsx file.

14. Table 1 and Table 2: Please change the time unit msec to ms. Please use the micro symbol μ instead of u (i.e., μ V). Please include a space before and after the \pm symbol. Please use the period symbol (.) for the decimal separator (i.e., 55.1 instead of 55,1).

Answer: Time unit msec changed to ms while micro symbol was used instead of u. Space was used before and after \pm symbol, period symbol was used for the decimal separator.

15. Table of Materials: Please revise it to include information on all relevant supplies, reagents, equipment and software used, especially those mentioned in the Protocol. Please sort the items in alphabetical order according to the name of material/equipment.

Answer: Inserted in page 4 line 10-11

16. Please use superscript arabic numerals to cite references in text. The superscript number is inserted immediately next to the word/group of words it applies to but before any punctuation.

Answer: References were cited by using superscript Arabic numerals in text.

Reviewers' comments:

Reviewer #1:

Manuscript Summary:

The authors presented the transaxillary first ribs resection technique using for treatment of the thoracic outlet syndrome (TOS). TOS caused by the compression of the brachial plexus, subclavian vein and artery. They described their techniques very well.

Major Concerns:

I think they should give their recurrent rate of symptoms and other site recurrence. And if it is possible they may add some figures of the provocative tests for diagnosis.

Answer: A figure was added to describe provocative tests while recurrence rates have been mentioned in results section(page 6 line 21-23).

Minor Concerns:

There are some mistakes of English. It should be corrected. The number of patients and characteristics should be written in the results section or they can add a table for this. Because some patients who had TOS may work in handpower work.

They should add some labels for tables.

Answer: A description including characteristics of patients have been inserted in results section(page 6 line 8-10). Labels were added to tables. English revision has been conducted by a native speaker.

1) There are some mistakes of English language. For example "protokol" should be protocol, "pnemothorax" should be pneumothorax, "physical therapy" should be physiotherapy, etc. "Nonsteroidal anti inflamatuars" should be Nonsteroidal anti inflammatory drugs. Maybe it could be edited by native speaker.

Answer: English revision has been conducted by a native speaker.

2) If it is possible you can add some figures of the provocative tests for diagnosis.

Answer: A figure describing provocative tests was added.

3) You should give your recurrent rate of symptoms and other site recurrence if you have. And also if you have, when?

Answer: Information regarding recurrence rates has been included in page 6 line 19-23.

4) The number of patients and characteristics should be written in the results section or they can add a table for this. Because we know that some patients who had TOS work in handpower work. This effects the symptoms and postoperative recovery.

Answer: A description including characteristics of patients have been inserted in results section(page 6 line 8-10).

5) You have to add some labels for tables. You and I know that what MAC means that for example, however some readers couldnt know.

Answer: Abbreviations of terms used in tables were included as labels under all tables.

Reviewer #2:

Manuscript Summary:

1. Great video.
2. needs a lot of editing to resolve spelling/grammatical/flow language issues.

Answer: English revision has been conducted by a native speaker.

Major Concerns:

1. prophylactic antibiotics should not be given for 48 hrs. there is no evidence for this practice in any clean surgery. in fact, theres evidence that antibiotics are probably not even necessary for this operation.

Answer: This information has been removed from text.

2. i noticed in your video that you did a very excellent posterior rib resection until the articular surface of the transverse process is seen. I think this is 100% important to ensure adequate resection. you should emphasize this in the manuscript.

Answer: Posterior rib resection procedure was mentioned in page 5 line 31-page 6 line 3, page 8 line 5-7.

3. conversely, in your manuscript, you mention importance of doing the anterior costoclavicular and subclavius muscle division, but i did not notice you doing that in the video?

Answer: Although this data was provided theoretically, this intervention couldn't have been seen due to recording issues.

4. your tables are poorly described in the manuscript.

Answer: Tables were mentioned in results section(page 6 line 15-16).

Minor Concerns:

1. in the introduction, you mention that the Transaxillary approach is the most commonly used in the USA, those references are old, and to date, it is impossible to assess which are the most common approaches because the claims/insurance databases for first rib resections are the same, 21615 for both transax, infraclavicular, or supraclavicular. so i suggest removing that statement.

Answer: This statement has been revised in page 2 line 29-31.

2. The adson's test should be done with the head rotated to both the ipsi and contralateral side. quite often, the compression will be elicited if the head is rotated to the contralateral side.

Answer: Adson's test description revised in page 3 line 13 and 15-16.

3. do you have any pictures/images of the patient positioning?

Answer: A picture of patient positioning has been added as a separate file.

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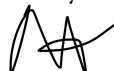
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