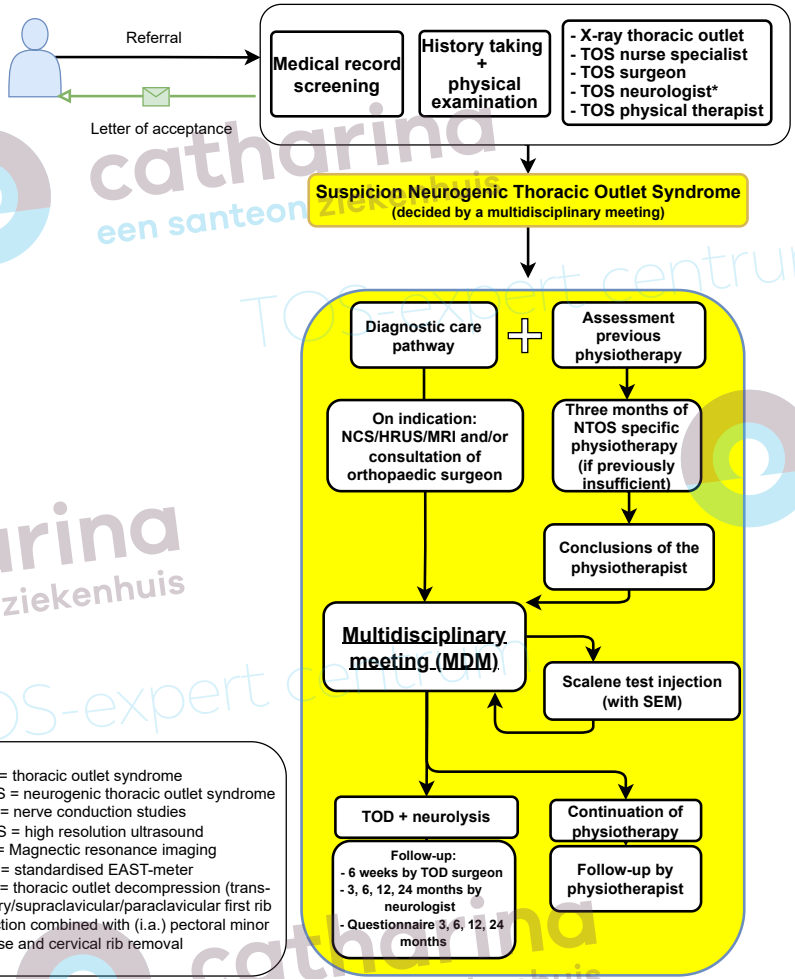
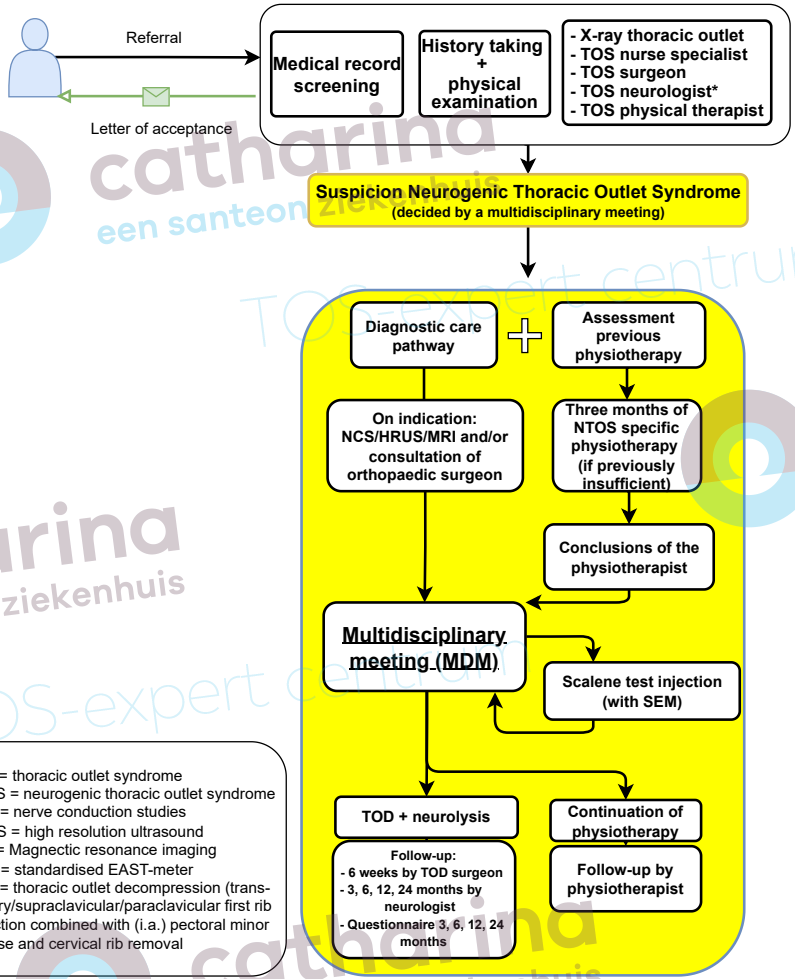
NTOS: wat hebben we geleerd de afgelopen jaren?

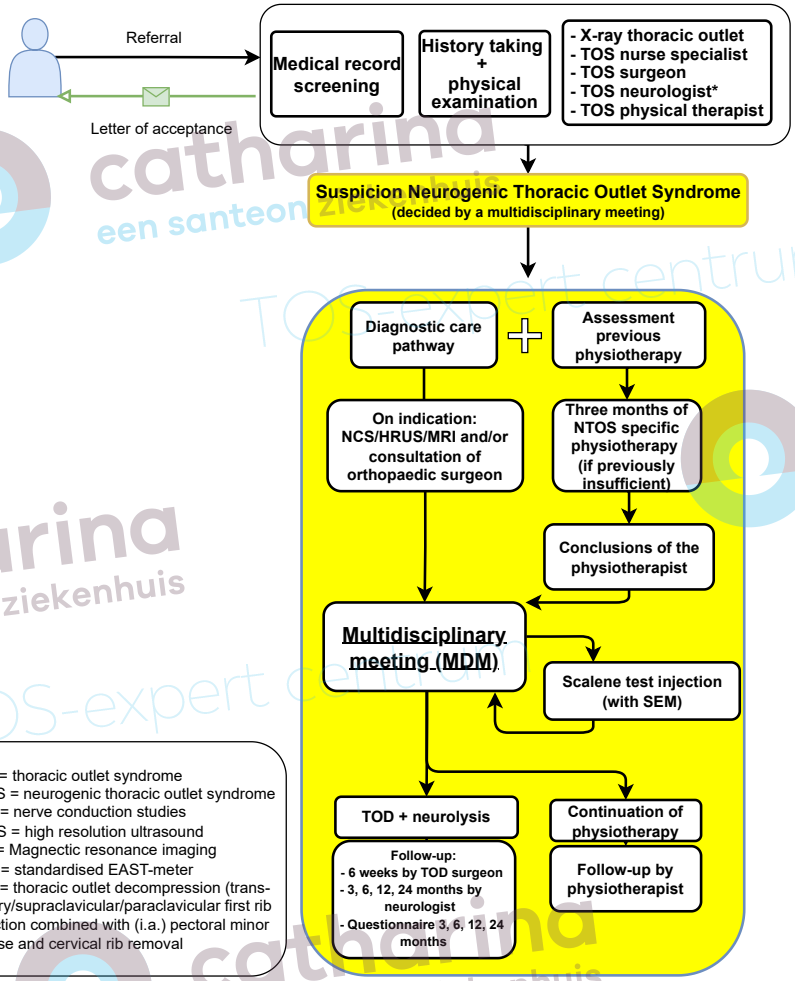
TOS 2.0 symposium

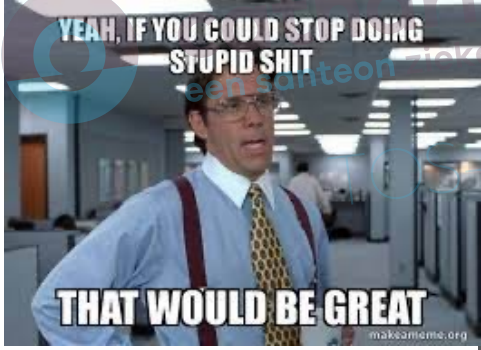
Jens Goeteyn


Referral
Letter of acceptance
Medical record screening
History taking + physical examination
- X-ray thoracic outlet
- TOS nurse specialist
- TOS surgeon
- TOS neurologist*
- TOS physical therapist
Suspicion Neurogenic Thoracic Outlet Syndrome
(decided by a multidisciplinary meeting)
Diagnostic care pathway
Assessment previous physiotherapy
On indication: NCS/HRUS/MRI and/or consultation of orthopaedic surgeon
Three months of NTOS specific physiotherapy (if previously insufficient)
Conclusions of the physiotherapist
Multidisciplinary meeting (MDM)
Scalene test injection (with SEM)
TOD + neurolysis
Continuation of physiotherapy
Follow-up:
- 6 weeks by TOD surgeon
- 3, 6, 12, 24 months by neurologist
- Questionnaire 3, 6, 12, 24 months
Follow-up by physiotherapist
TOS = thoracic outlet syndrome
NTOS = neurogenic thoracic outlet syndrome
NCS = nerve conduction studies
HRUS = high resolution ultrasound
MRI = Magnectic resonance imaging
SEM = standardised EAST-meter
TOD = thoracic outlet decompression (trans-axillary/supraclavicular/paraclavicular first rib resection combined with (i.a.) pectoral minor release and cervical rib removal



Wat we wél doen

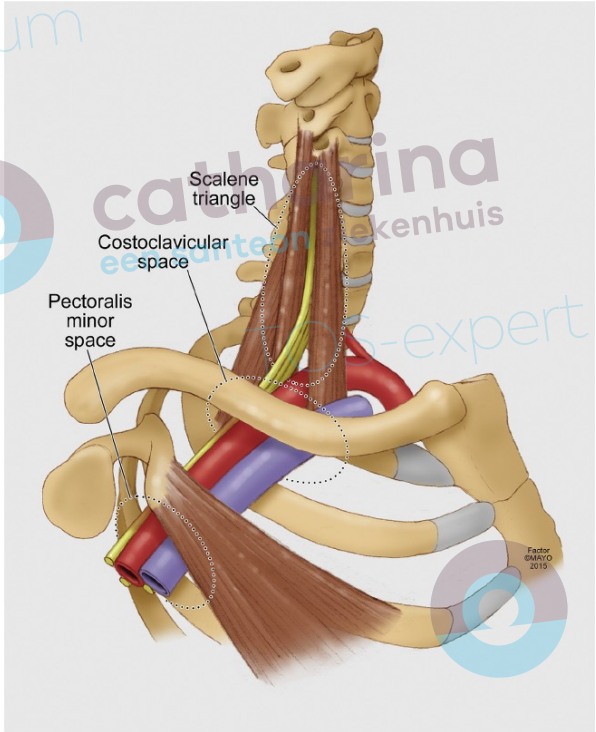




Wat doen we niet (meer)??

Overzicht

- **Controverse NTOS**
- **Diagnostiek**
  - Duplex (CTA-MRA)
  - Lichamelijk onderzoek + EAST
  - Echo (HRUS)
  - EMG
  - Proefblok
  - MR plexus
- **Resultaten**



1. Controverse NTOS: wetenschap

THE COCHRANE COLLABORATION®

2014

One of the most controversial clinical entities in medicine

Lack of uniform scientific evidence

1. Controverse NTOS

GESCHIEDENIS

DIAGNOSE

WETENSCHAPPELIJKE LITERATUUR

1. Controverse NTOS

GESCHIEDENIS

DIAGNOSE

= ONZEKER!!

WETENSCHAPPELIJKE LITERATUUR

= KUNNEN WE AUTEURS VERTROUWEN EEN ECHTE NTOS TE DIAGNOSTICEREN?

1. Controverse NTOS

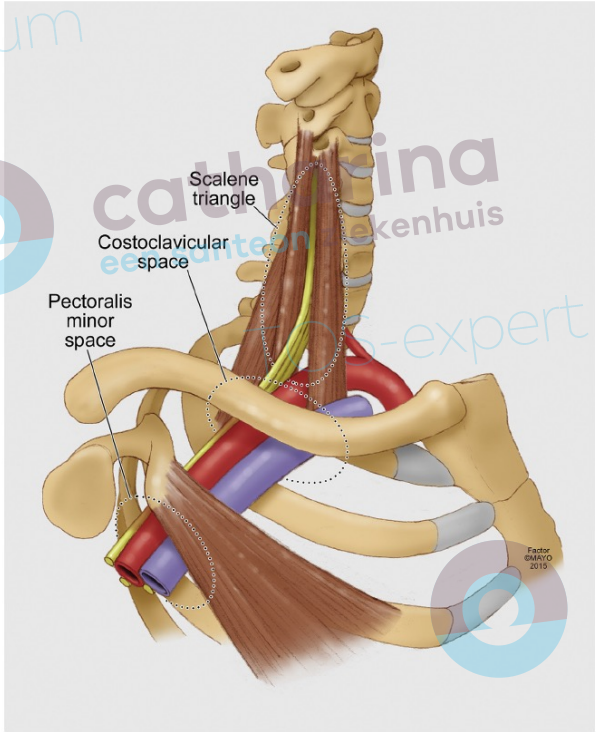
Reporting standards of the Society for Vascular Surgery for thoracic outlet syndrome

Karl A. Illig, MD,[a] Dean Donahue, MD,[b] Audra Duncan, MD,[c] Julie Freischlag, MD,[d] Hugh Gelabert, MD,[e] Kaj Johansen, MD,[f] Sheldon Jordan, MD,[g] Richard Sanders, MD,[h] and Robert Thompson, MD,[i] *Tampa, Fla; Boston, Mass; London, Ontario, Canada; Sacramento and Los Angeles, Calif; Seattle, Wash; Aurora, Colo; and St. Louis, Mo*

- **2016: Reporting standards for TOS**
- ***“ to produce consistency in diagnosis, description of treatment and assesment of results to allow for more valuable data to be reported ”***
  - Diagnostische criteria
  - Terminologie
  - Gevalideerde uitkomst maten

Overzicht

- **Controverse NTOS**
- **Diagnostiek**
  - Duplex (CTA-MRA)
  - Lichamelijk onderzoek + EAST
  - Echo (HRUS)
  - EMG
  - Proefblok
  - MR plexus
- **Resultaten**



Duplex

Duplex wordt routinematig gebruik in de work-up van TOS

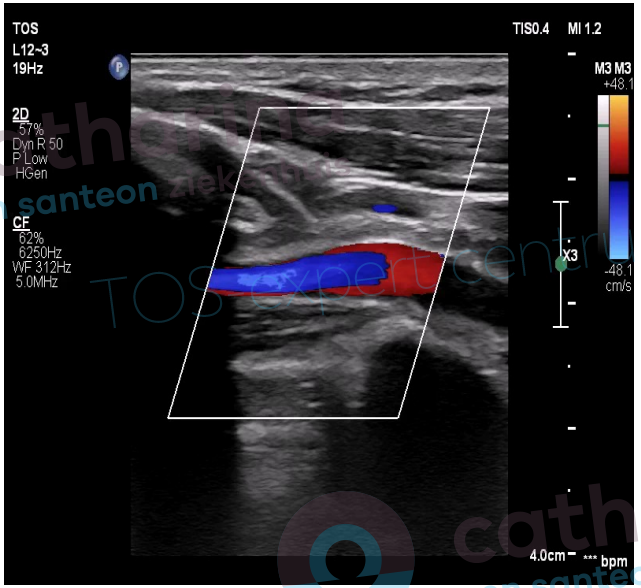
Verschillende TOS experts raden een duplex aan bij elke vorm van TOS:

→ Opzoeken/uitsluiten ATOS of VTOS

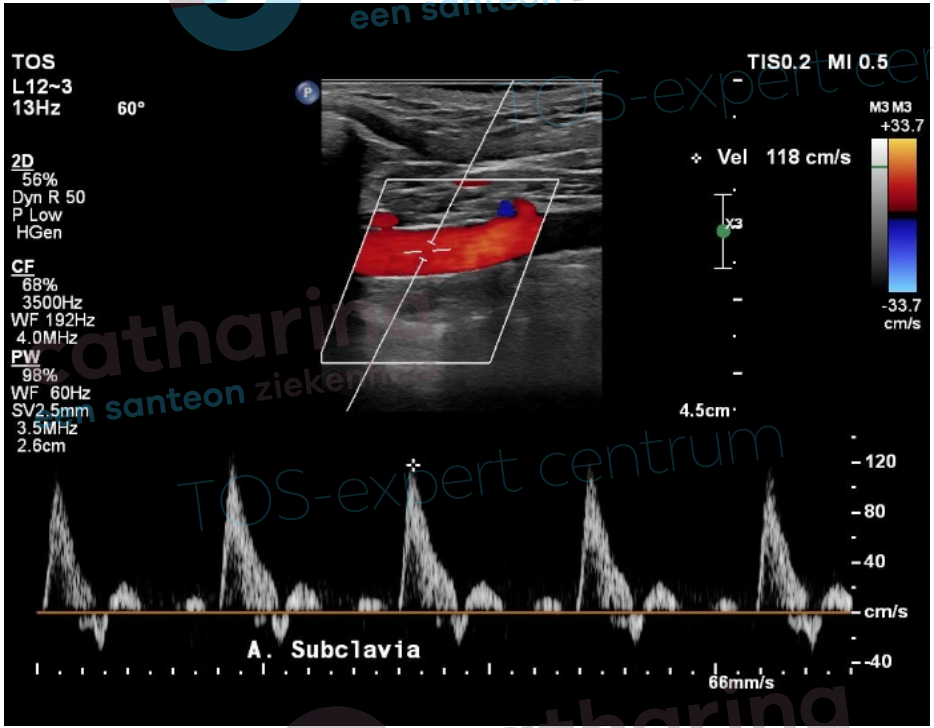
→ Compressie van de arterie suggereert dat ook de plexus gecomprimeerd kan worden… (???)

→ Veel patienten met TOS hebben:
- Kleurverschil vingers
- Koudegevoel
- Uitgelokt door arm boven schouderniveau

→ Veel artsen wijten deze klachten aan compressie van de arterie bij elevatie van de arm.



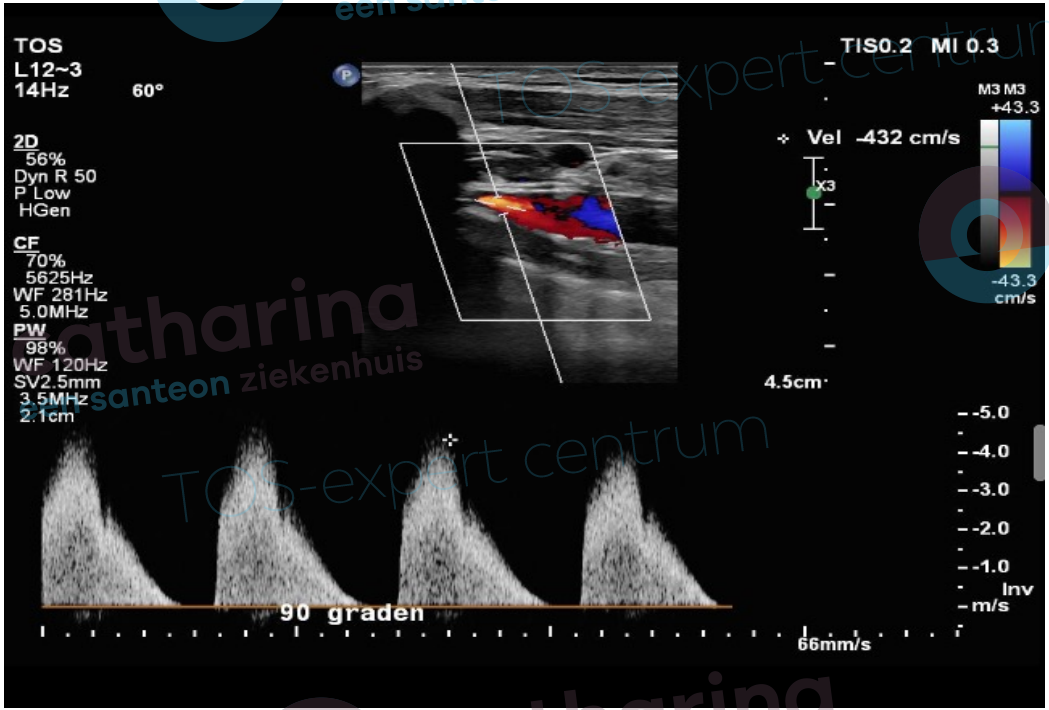
Duplex



a.subclavia mid
In rust

PSV: 118 cm/s
Trifasisch dopplersignaal
Brede diameter

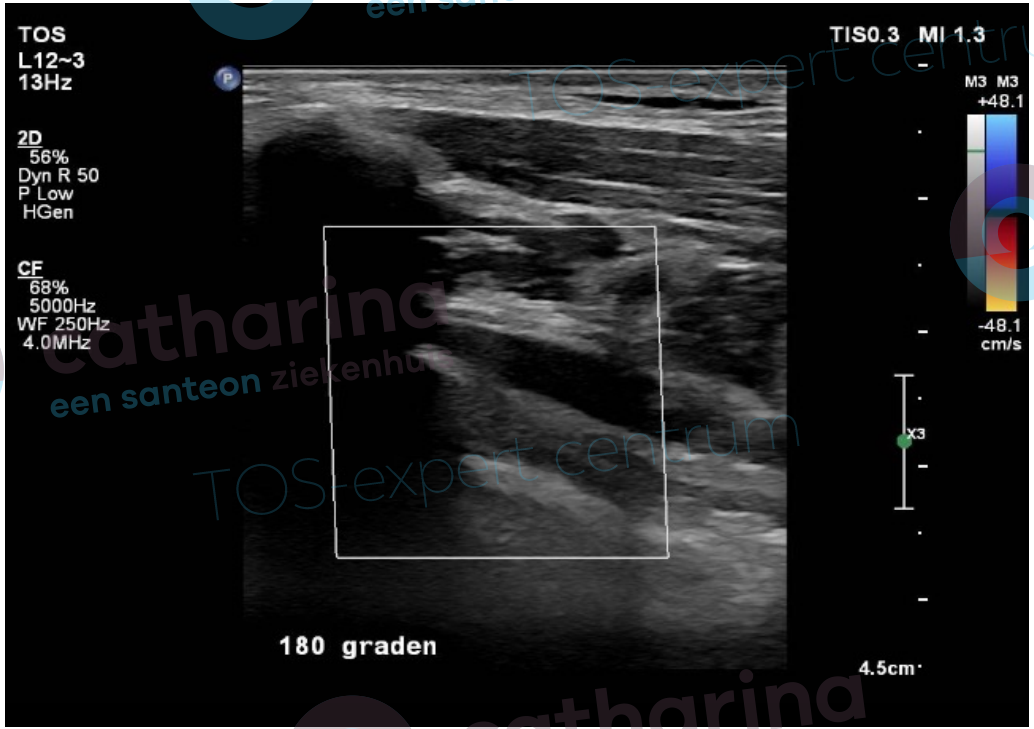
Duplex



a.subclavia mid
90 gr abductie

PSV: 432 cm/s
Monofasisch dopplersignaal
Smalle diameter

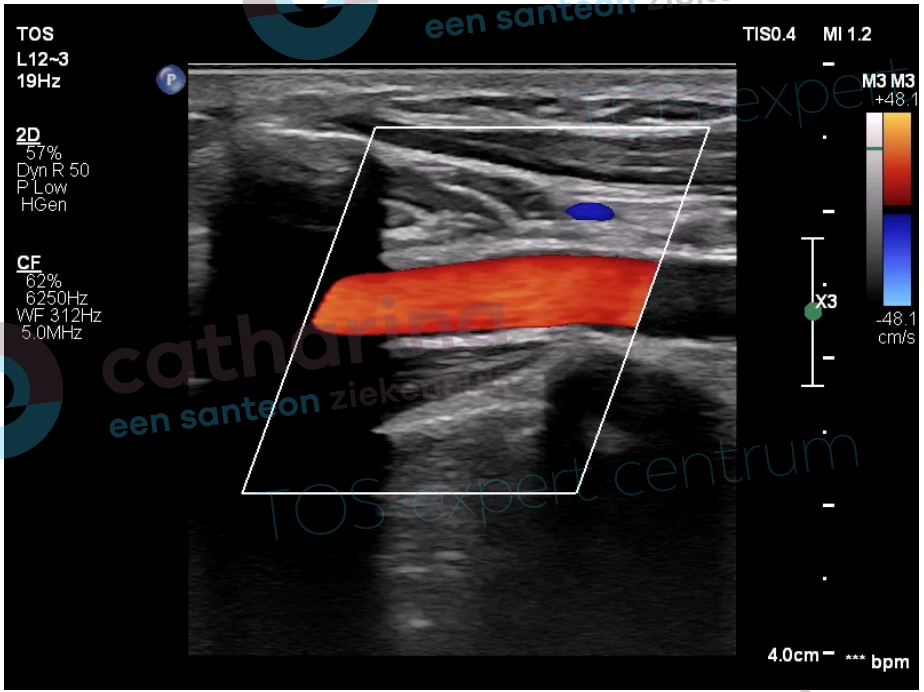
Duplex



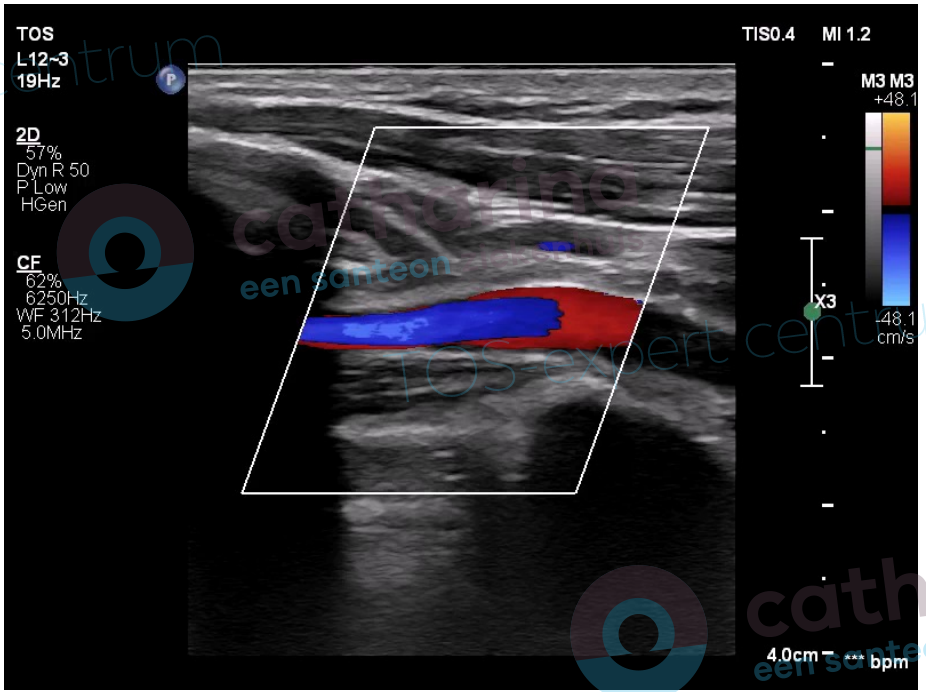
a.subclavia mid
180 gr abductie

Geen flow in de a.subclavia

Duplex



Van rust positie naar 90 gr abductie



Van 90 naar 180 graden abductie

Duplex

MAAR!

1. Stenose op duplex is geen ATOS

2. Stenose op duplex: waarde?

Afwijkingen in de a.subclavia ook zichtbaar bij gezonde populatie !!

Duplex

MAAR!

1. Stenose op duplex is geen ATOS

2. Stenose op duplex: waarde?

Afwijkingen in de a.subclavia ook zichtbaar bij gezonde populatie !!

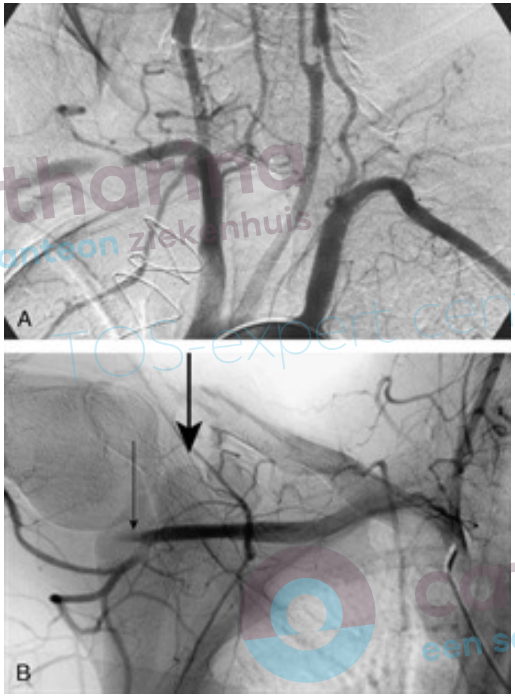
Duplex: definitie ATOS

REPORTING STANDARDS:

- **Objectief vast te stellen schade van de A. Subclavia**
  - Ter hoogte van de basis scalenius driehoek +- costoclaviculair

    Symptomen:
    - Ischemie tgv occlusie
    - Embolisatie

    Geen symptomen:
    - Aneurysma
    - Occlusie/stenose
- **Ischemie bij arm-elevatie (verkrampende spieren, …) / embolen**
- **Verkleuringen vingers/tempverschil ≠ ATOS !!**
  - Raynaud, OS stimuli, …



Duplex: definitie ATOS

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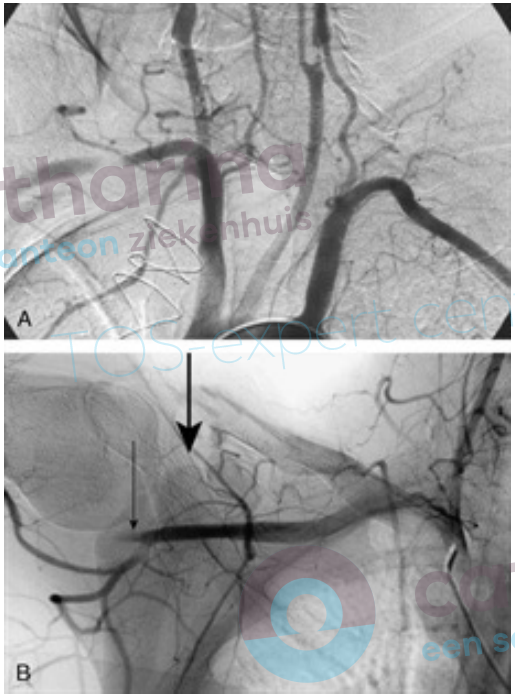


Duplex

MAAR!

1. Stenose op duplex is geen ATOS

2. Stenose op duplex: waarde?

Afwijkingen in de a.subclavia ook zichtbaar bij gezonde populatie !!

Duplex

- **Afwijkingen a.subclavia in gezonde populatie**
  - **Duplex: 12 % heeft a.subclavia compressie (>50 %)**

- **Afwijkingen a.subclavia in gezonde populatie/patiënten**

Table 2. Mean Arterial Stenosis in the Interscalene Triangle, Costoclavicular Space, and Retropectoralis Minor Space in Volunteers (n = 45) and Patients (n = 28)

	Mean Arterial Stenosis ± SD, %								
	Interscalene Triangle			Costoclavicular Space			Retropectoralis Minor Space		
Abduction	Volunteers	Patients	*P*	Volunteers	Patients	*P*	Volunteers	Patients	*P*
90°	6 ± 14	6 ± 5	.55	18 ± 13	53 ± 30	<.01	2 ± 13	4 ± 9	.18
130°	8 ± 12	8 ± 6	.99	20 ± 16	78 ± 24	<.01	5 ± 13	7 ± 12	.43
170°	9 ± 11	10 ± 6	.82	32 ± 29	83 ± 23	<.01	5 ± 13	5 ± 11	.93

Article

A Prospective Evaluation of Duplex Ultrasound for Thoracic Outlet Syndrome in High-Performance Musicians Playing Bowed String Instruments

Garret Adam [1], Kevin Wang [2], Christopher J. Demaree [3], Jenny S. Jiang [4], Mathew Cheung [5], Carlos F. Bechara [6] and Peter H. Lin [1,5,*]

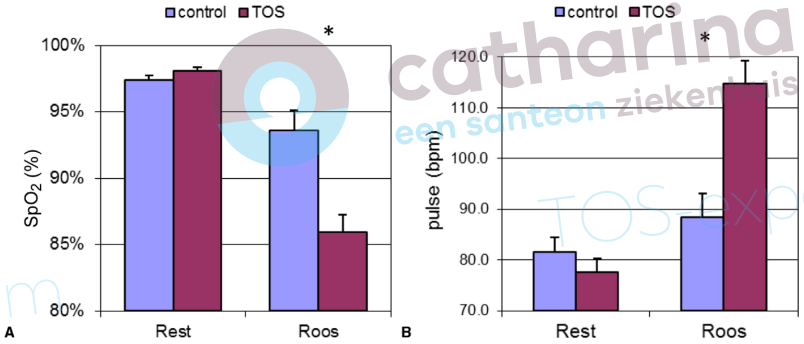
Ultrasonographic Assessment of Arterial Cross-sectional Area in the Thoracic Outlet on Postural Maneuvers Measured With Power Doppler Ultrasonography in Both Asymptomatic and Symptomatic Populations

Xavier Demondion, MD, Clément Vidal, MS, Pascal Herbinet, MD, Corinne Gautier, MD, Bernard Duquesnoy, MD, Anne Cotten, MD

Duplex: PPG

- **PO2 meting:**
  - N = 36
  - 18 'non-specific NTOS'
  - 18 asymptomatische patienten
  - EAST

Pulse Oximetry Measurements in the Evaluation of Patients With Possible Thoracic Outlet Syndrome



- N = 42
- NTOS diagnose
- PPG
- 15 mm Hg daling tijdens EAST
  - Sens 67%
  - Spec 78%

Microvascular Response to the Roos Test Has Excellent Feasibility and Good Reliability in Patients With Suspected Thoracic Outlet Syndrome

Samir Henni[1,2], Jeanne Hersant[1], Myriam Ammi[3], Fatima-Ezzahra Mortaki[4], Jean Picquet[2,3], Mathieu Feuilloy[5] and Pierre Abraham[2,4*]

ATOS-NTOS mengbeeld

- **PO2 meting:**
  - N = 130
  - Gezonde proefpersonen
  - PPG
  - Unilateraal afwijkingen: 60%
  - Bilateraal afwijkingen 33%

Angiology. 1980 Aug;31(8):538-41.

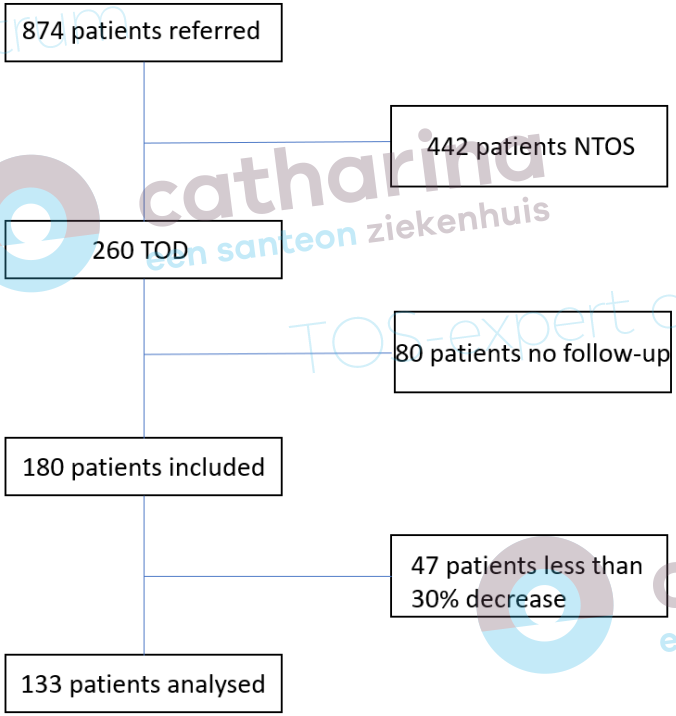
Thoracic outlet arterial compression: prevalence in normal persons.

Gergoudis R, Barnes RW.

Duplex

EIGEN ONDERZOEK

- **2 VRAGEN:**
  - WAT IS DE DIAGNOSTISCHE WAARDE VAN DUPLEX BIJ NTOS?
  - WAT IS DE WAARDE VAN DE ZOGENAAMDE ‘VASCULAIRE SYMPTOMEN’
- **Bewezen NTOS patienten**
- **Retrospectief: gestandardiseerd verslag volgens reporting standards**



Duplex

- **EIGEN ONDERZOEK**
  - Bewezen NTOS patienten
  - Retrospectief: gestandardiseerd verslag volgens reporting standards

Table II. Summary of symptomatology possibly caused by arterial compression

History & clinical assessment		
Color changes fingers/hand	40/133	30,10%
Temperature changes fingers/hand	31/133	23,30%
Edema fingers/hand	19/133	14,30%
Color changes fingers/hand during EAST	32/133	24,10%
Temperature changes fingers/hand during EAST	16/133	12%
"Arterial" symptoms (yes if one of above positive)	49/133	36,80%

Duplex

- EIGEN ONDERZOEK

Table III. Overview of aberrant findings on duplex ultrasound comparing variation in peak systolic velocity (PSV) and occlusion of the of the subclavian artery during provocative maneuvers

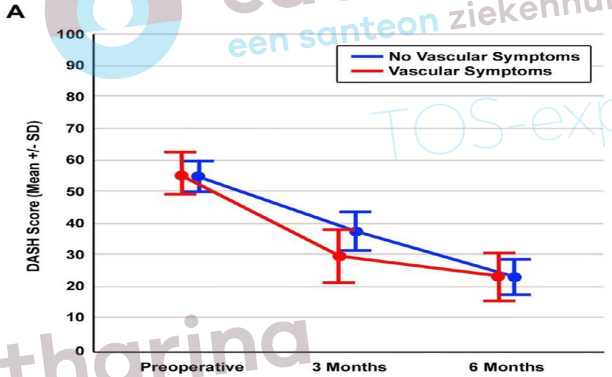
Duplex ultrasound		
50% variation in PSV 0-90-180°	51/133	38,30%
Occlusion 0-90-180°	11/133	8,30%

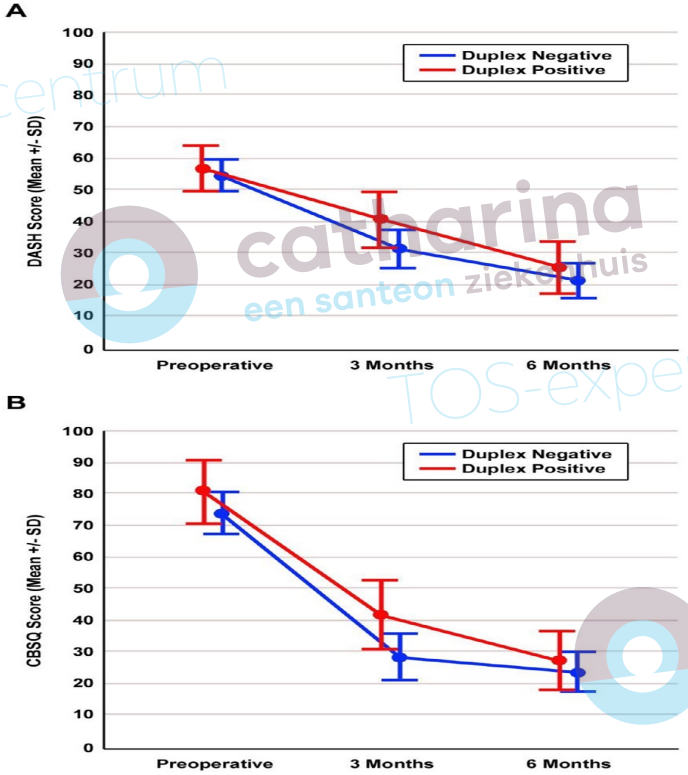
Table IV. Overview of absolute numbers of patients with "arterial symptoms" and abnormal findings on duplex ultrasound

	Duplex aberrant NO	Duplex aberrant YES	Total
"Arterial symptoms" NO	54	30	84
"Arterial symptoms" YES	28	21	49
Total	82	51	133

A X^2-test was performed with $P = 0.414$.

Duplex


A
DASH Score (Mean +/- SD)
No Vascular Symptoms
Vascular Symptoms
Preoperative
3 Months
6 Months
B
CBSQ Score (Mean +/- SD)
No Vascular Symptoms
Vascular Symptoms
Preoperative
3 Months
6 Months


A
DASH Score (Mean +/- SD)
Duplex Negative
Duplex Positive
Preoperative
3 Months
6 Months
B
CBSQ Score (Mean +/- SD)
Duplex Negative
Duplex Positive
Preoperative
3 Months
6 Months

Duplex

- **CONCLUSIE**

VTOS: rol van duplex = dubieus

- Vals negatief 21%
- Waarde van collateralen

ATOS: rol van duplex = nooit geobjectiveerd

- DD andere etiologie van occlusie (aortaboog, basis subclavia, AF,…)

NTOS: rol van duplex = nutteloos

False-negative upper extremity ultrasound in the initial evaluation of patients with suspected subclavian vein thrombosis due to thoracic outlet syndrome (Paget-Schroetter syndrome)

Evan R. Brownie, MD, Ahmmad A. Abuirqeba, BA, J. Westley Ohman, MD, Brian G. Rubin, MD, *and* Robert W. Thompson, MD, *St. Louis, Mo*

Duplex Ultrasound Studies Are Neither Necessary or Sufficient for the Diagnosis of Neurogenic Thoracic Outlet Syndrome

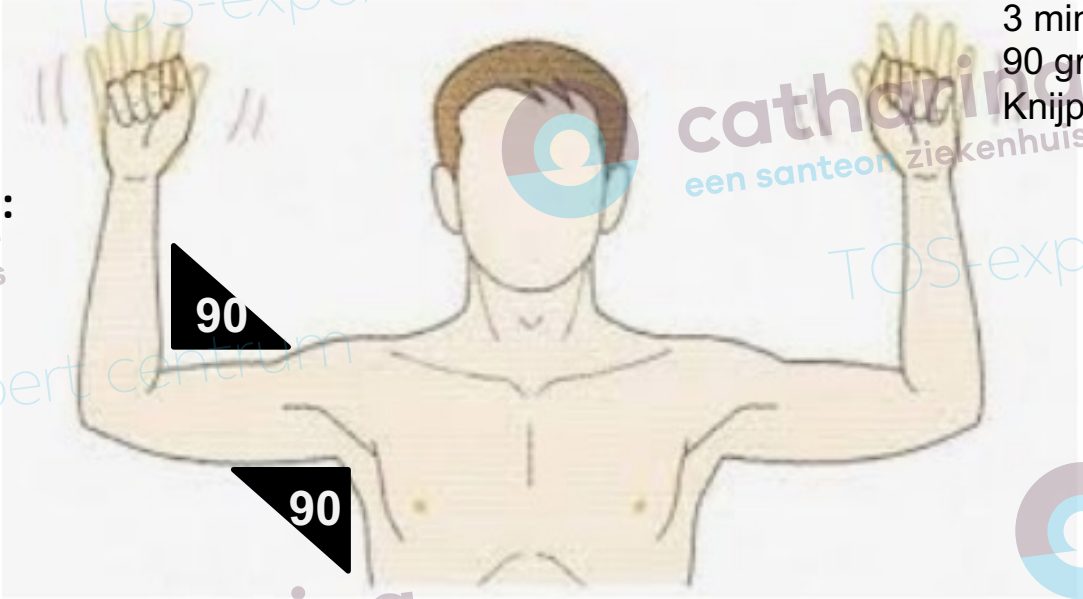
Jens Goeteyn,[1] Niels Pesser,[1] Marc R.H.M. van Sambeek,[1,2] Robert W Thompson,[3] Bart F.L van Nuenen,[4] and Joep A.W. Teijink,[1,5] Eindhoven, The Netherlands; St. Louis, MO; Maastricht, The Netherlands

2. EAST

Elevated Arm Stress test:

Sensitiviteit 30 %

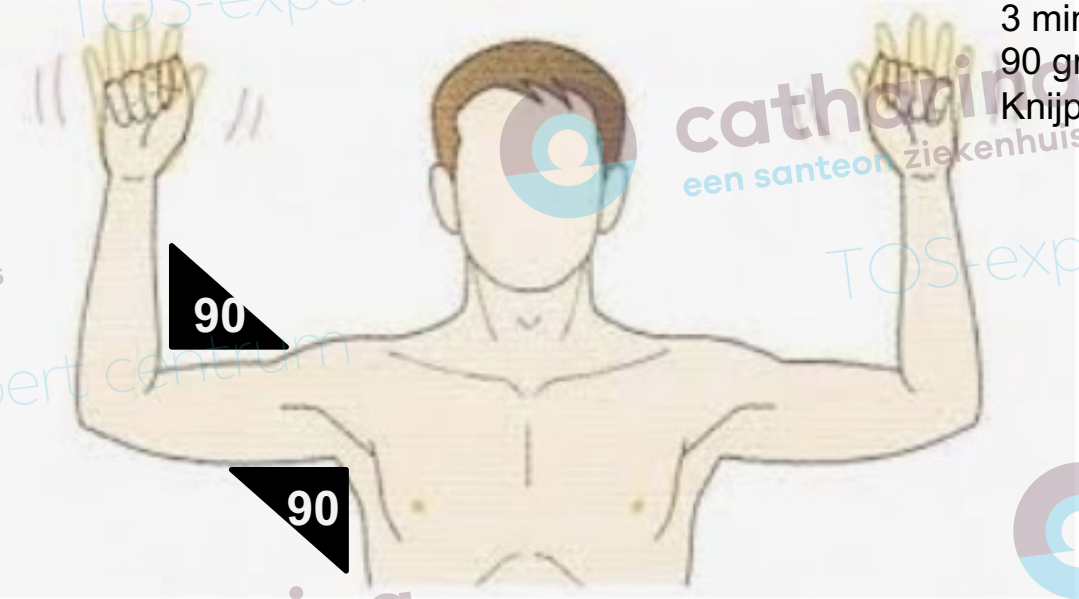
Specificiteit 84 %



3 minuten
90 graden
Knijpen/ontspannen

2. EAST

- **Houding patiënt?**
- **Wanneer positief?**
- **Wanneer negatief?**



3 minuten
90 graden
Knijpen/ontspannen

2. EAST

Journal of Vascular Surgery
Volume 76, Issue 3, September 2022, Pages 814-820

Clinical research study
Thoracic outlet syndrome

Reliability and validity of the elevated arm stress test in the diagnosis of neurogenic thoracic outlet syndrome

Presented at the 2021 Vascular Annual Meeting of the Society for Vascular Surgery, San Diego, CA, August 18-21, 2021.

Niels Pesser MD [a,b], Britt I. de Bruijn MSc [a,c], Jens Goeteyn MD [a,b], Saskia Houterman MSc, PhD [d], Marc R.H.M. van Sambeek MD, PhD [a,e], Robert W. Thompson MD [f], Joep A.W. Teijink MD, PhD [a,b], Bart F.L. van Nuenen MD, PhD [a]

The AUC value of duration was 0.62 (CI: 0.55 - 0.69) meaning *duration had a 62% chance to distinguish patients with proven NTOS from symptomatic controls* based on the outcomes of duration of the EAST.

Table 5: The Intraclass Correlation Coefficient estimates with their 95% Confidence Intervals of the Elevated-Arm-Stress-Test-Measurement-parameters

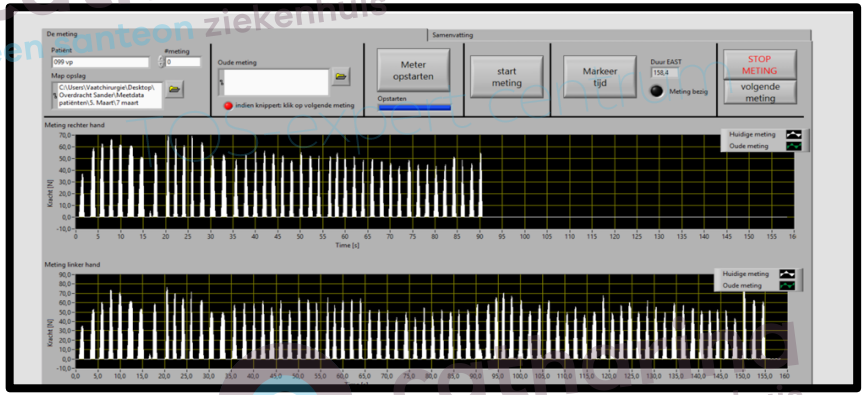
		Subanalysis groups		Subanalysis time	
Parameter	Total	Proven NTOS group	Non-NTOS group	Total, ≤ 30 days between measurements	Total, > 30 days between measurements
Duration	0.65 (0.55-0.74)	0.61 (0.47-0.71)	0.83 (0.68-0.91)	0.63 (0.46-0.76)	0.65 (0.51-0.76)

Note: NTOS = neurogenic thoracic outlet syndrome.

2. EAST

Standaardiseren van de EAST meting

- Elke patient dezelfde houding
  - Armen 90° abductie
  - Blijven in dezelfde houding tijdens de test
- Amplitude, ritme, krachtmeting



2. EAST

Standaardiseren van de EAST meting (sEAST)

- Elke patient dezelfde houding
  - Armen 90° abductie
  - Blijven in dezelfde houding tijdens de test
- Amplitude, ritme, krachtmeting
- Sensibiliteit en specificiteit laag
- Test-retest reabiliteit hoog!
  - Vnl waarde proefblock objectiveren!

2. EAST

ELSEVIER

Journal of Vascular Surgery

Volume 76, Issue 3, September 2022, Pages 821-829.e1

Clinical research study

Thoracic outlet syndrome

Reliability and validity of the standardized elevated arm stress test in the diagnosis of neurogenic thoracic outlet syndrome

Niels Pesser MD [a, d], Britt I. de Bruijn MSc [a, e], Jens Goeteyn MD [a, d], Nicole Verhofstad MSc, PhD [a], Saskia Houterman MSc, PhD [b], Marc R.H.M. van Sambeek MD [a, f], Robert W. Thompson MD, PhD [g], Bart F.L. van Nuenen MD, PhD [c], Joep A.W. Teijink MD, PhD [a, d]

3. HRUS

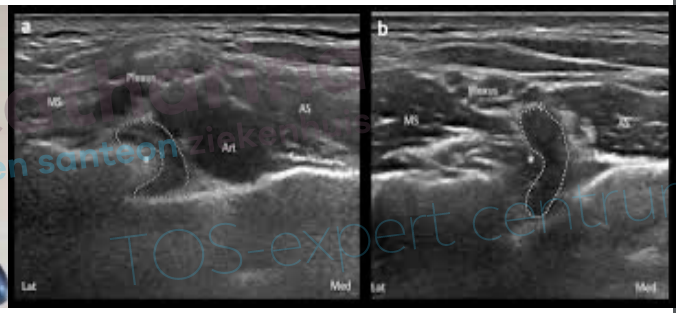
- **Echo - HRUS**
  - High resolution ultrasound
  - Wedge-sickle sign
    - Sens 95%
      - 19/20 TOS patiënten
        - 0/25 controle patiënten
    - Hyper-echogene fibromusc structuur met compressie van de onderste delen van de plexus

Ultrasound in Medicine & Biology
Volume 42, Issue 10, October 2016, Pages 2357-2366

Original Contribution

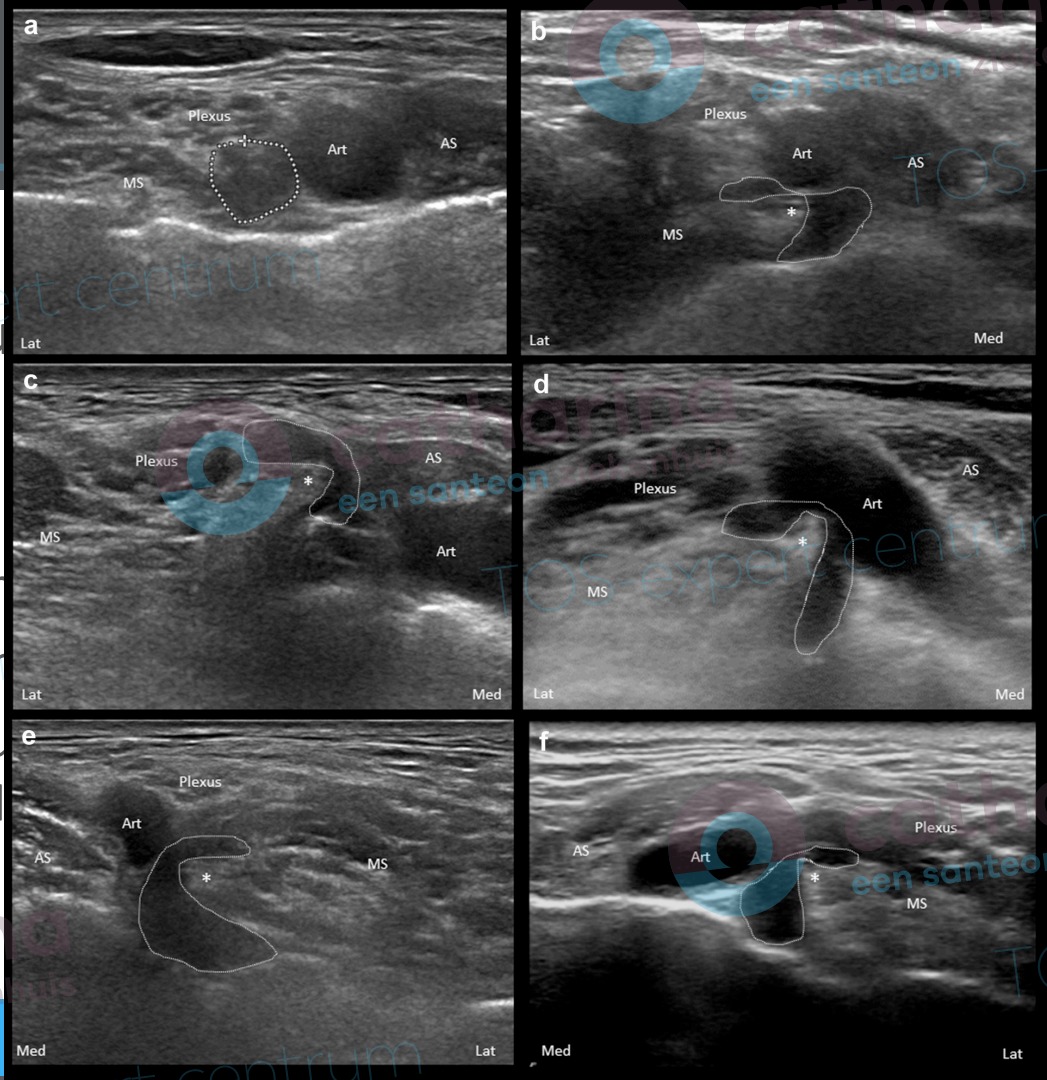
Ultrasonographic Identification of Fibromuscular Bands Associated with Neurogenic Thoracic Outlet Syndrome: The "Wedge-Sickle" Sign

Zsuzsanna Arányi *, Anita Csillik *, Josef Böhm †, Thomas Schelle ‡



3. HRUS

- **HRUS**
  - High resolution ultrasou
  - Wedge-sickle sign
    - Sens 95%
      - 19/20 TOS patiënter
        - 0/25 Controle patiën
    - Hyper-echogene fibromu
      onderste delen van de pl



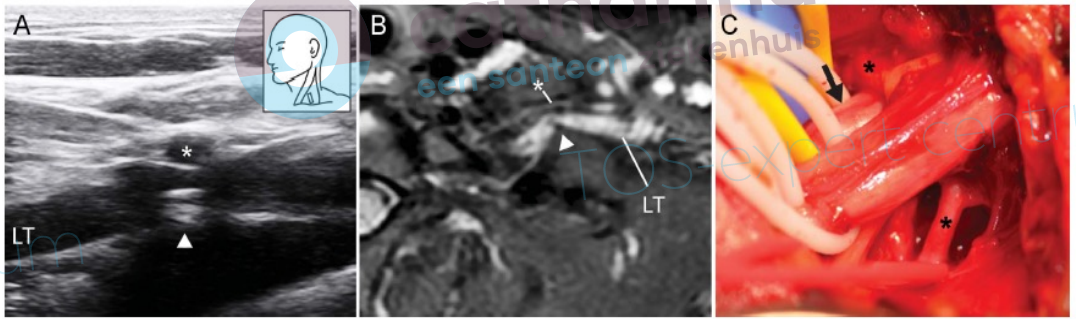
3. HRUS

- **HRUS**
  - High resolution ul
  - Wedge-sickle sign
    - Case reports

NEUROIMAGES

Sonographic diagnosis of true neurogenic thoracic outlet syndrome

Figure Imaging findings in true neurogenic thoracic outlet syndrome



Correlation between ultrasound (A) and MRI (B) demonstrates compression of the lower trunk (LT) between an artery (*) and fibrous band (arrowhead) arising from an elongated C7 transverse process. At operation (C), the artery (*) passed between the middle and lower trunks. Fibrous bands were resected to release the LT (arrow).

A 32-year-old woman presented with a 5-year history of left shoulder pain, medial hand and forearm numbness, and progressive hand weakness and atrophy. Electrodiagnostic studies were characteristic of true neurogenic thoracic outlet syndrome,[1] and a chest x-ray showed bilateral elongated C7 transverse processes. High-resolution ultrasound studies revealed compression of the left lower trunk (LT) between a fibrous band and artery (figure, A). Magnetic resonance neurography (figure, B) and operative exploration (figure, C) confirmed the ultrasound findings. Clinical improvement was noted following surgical neurolysis of the LT. High-resolution ultrasound may be a useful and quick bedside tool to identify causative structural pathology in this classic neuromuscular disorder.

3. HRUS

- **HRUS**
  - High resolution ultrasound
  - Wedge-sickle sign
    - CZE 2018
    - Prospectief
    - 54 patiënten HRUS bilateraal

European Journal of Vascular and Endovascular Surgery

Volume 59, Issue 5, May 2020, Pages 852-853

ELSEVIER

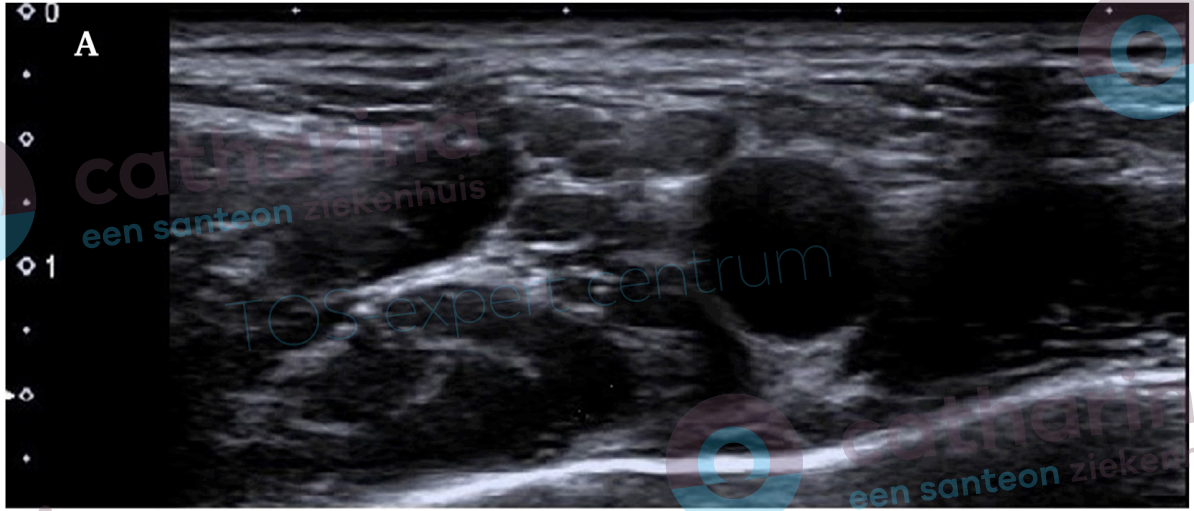
Research Letter

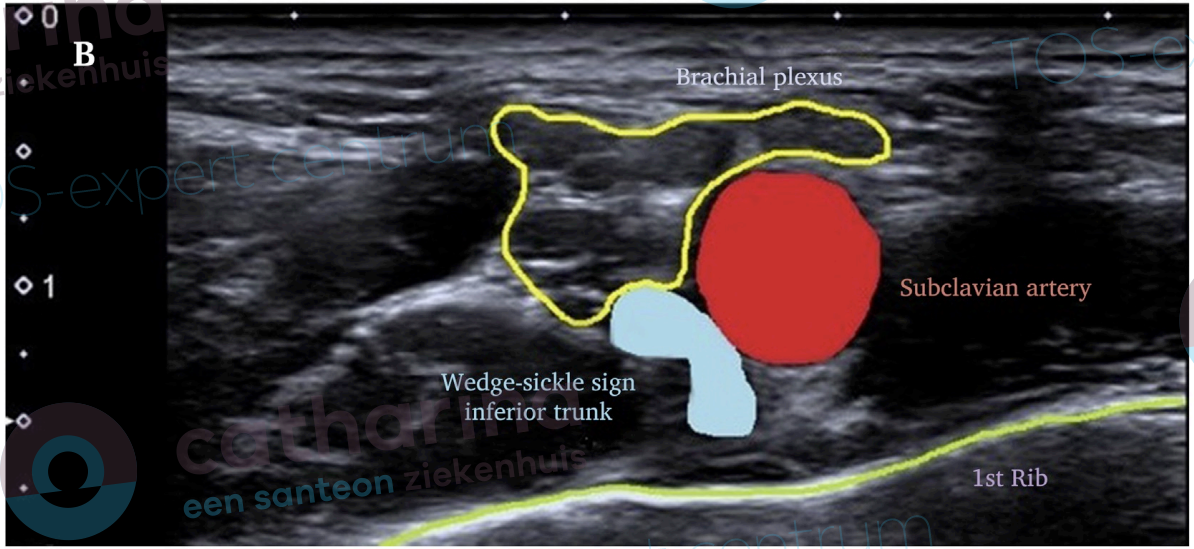
Value of Ultrasound in the Diagnosis of Neurogenic Thoracic Outlet Syndrome

Niels Pesser, Joep A.W. Teijink, Kimberly Vervaart, Jens Goeteyn, Rob A.R. Gons, Marc R.H.M. van Sambeek, Bart F.L. van Nuenen

3. HRUS

- **HRUS**
  - High
  - Wed
    - (
    - F
    - S

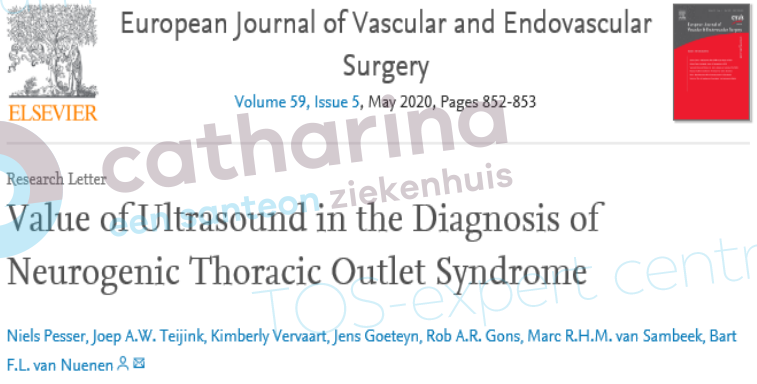




sis of Neurogenic

3. HRUS

- **HRUS**
  - High resolution ultrasound
  - Wedge-sickle sign
    - CZE 2018
    - Prospectief
    - 54 patiënten HRUS bilateraal
      - 36 patienten NTOS (49 armen)
      - ‘Correcte diagnose’ verzekerd door DASH/CBSQ
      - 4 armen met wedge sickle sign
        - » ¾ Gilliat Sumner Hand!



European Journal of Vascular and Endovascular Surgery

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Research Letter

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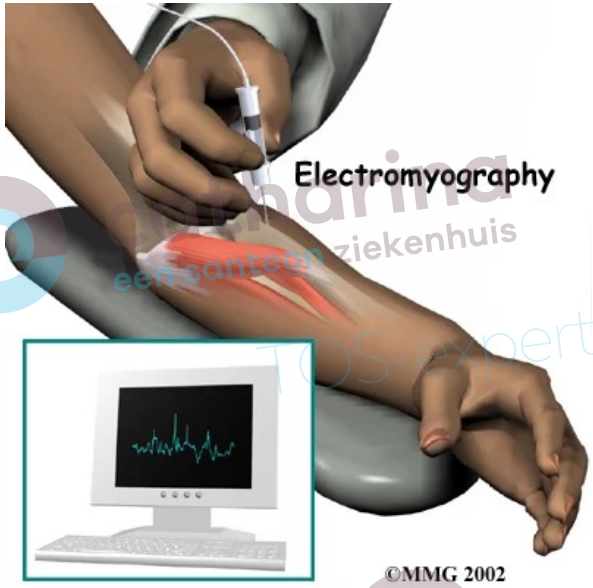
4. EMG

- **NTOS**
  - Medial Antebrachial Cutaneous (MABC) sensory nerve potential gedaald



ELSEVIER

Clinical Neurophysiology

Volume 115, Issue 10, October 2004, Pages 2316-2322

Medial antebrachial cutaneous nerve conduction study, a new tool to demonstrate mild lower brachial plexus lesions. A report of 16 cases

P. Seror

Clinical, electrodiagnostic and imaging features of true neurogenic thoracic outlet syndrome: Experience at a tertiary referral center☆

Sun Woong Kim[a], Ji Seon Jeong[a], Byoung Joon Kim[b], Yeon Hyeon Choe[c], Young Cheol Yoon[c], Duk Hyun Sung[a,*]

ABSTRACT

Objective: True neurogenic thoracic outlet syndrome (TN-TOS) is an extremely rare neuromuscular disease. We report clinical, electrodiagnostic and radiologic features of patients with TN-TOS.

Methods: Retrospective chart review of patients satisfying criteria was done. Nerve conduction study (NCS) and needle electromyography (EMG) of upper extremity were reviewed. Brachial plexus MRI and computed tomography angiography (CTA) were also reviewed.

Results: Thirteen TN-TOS patients were identified. The most common neurologic signs were hypesthesia in the medial forearm or ulnar digits and weakness of the abductor pollicis brevis (APB) muscle. In NCS, medial antebrachial cutaneous (MABC) sensory nerve action potential amplitude was decreased in all tested patients. The APB muscle was most commonly involved in EMG. Among radiologic criteria, focal stenosis of subclavian artery in CTA was the most common finding.

Conclusion: We confirmed that TN-TOS is T1 predominant lower roots/trunk brachial plexopathy with clinical and electrodiagnostic features. Radiologic studies may be used to detect structural abnormalities.

Significance: As MABC NCS showed abnormal results in all tested patients, it should be added to electrodiagnostic study as screening method. If present, structural abnormalities might be confirmed with radiologic studies.

4. EMG

- **NTOS**
  - Medial Antebrachial Cutaneous (MABC) sensory nerve potential gedaald

CHAPTER 3

The diagnostic and predictive value of electrodiagnostic assessment in patients with suspected Neurogenic Thoracic Outlet Syndrome

N. Presser
J. Goeteyn
K. Vervaart
N. van Alfen
M.R.H.M. van Sambeek
J.A.W. Teijink
B.F.L. van Nuenen

Submitted to clinical neurophysiology

CLINICAL RESEARCH ARTICLE

MUSCLE&NERVE WILEY

See Editorial on pages 4-6 in this issue

Variability in electrodiagnostic findings associated with neurogenic thoracic outlet syndrome

Karlien Mul MD, PhD[1] | Niels Presser BSc[2,3] | Kimberly Vervaart BSc[4] | Joep Teijink MD, PhD[2,3] | Bart van Nuenen MD, PhD[4] | Nens van Alfen MD, PhD[1]

4. EMG

Table 3: 2x2 table to calculate the sensitivity, specificity, positive predictive value, and negative predictive value.

NTOS-specific electrodiagnostic deviations	NTOS diagnosis		
	Positive	Negative	Total
Positive	37	10	47
Negative	82	46	128
Total	119	56	175

Note: NTOS = neurogenic thoracic outlet syndrome

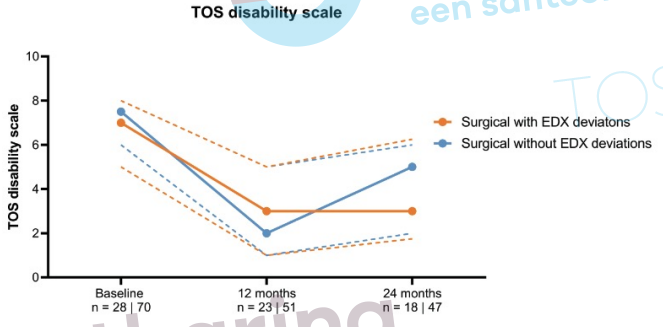


Figure 1a: median scores with interquartile range of the TOS disability scale at baseline, 12 and 24 months. *Note: EDX = electrodiagnostic (specific for NTOS). Wilcoxon signed-rank test between baseline and follow-up interval in with deviations group: 12 months p<0.001, 24 months p=0.005. Wilcoxon signed-rank test between baseline and follow-up interval in without deviations group: 12 months p<0.001, 24 months p<0.001 Mann-Whitney test between both surgical groups at the measured interval: baseline p=0.428, 12 months p=0.663, 24 months p=0.723.*

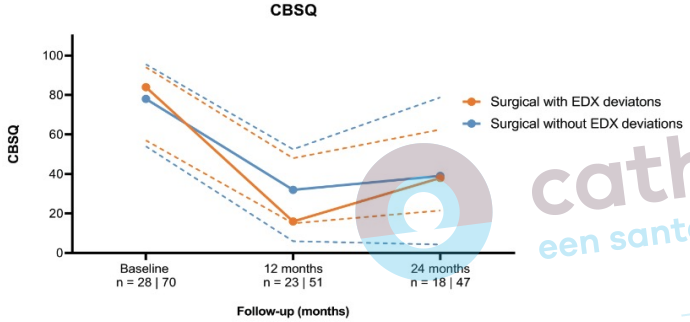


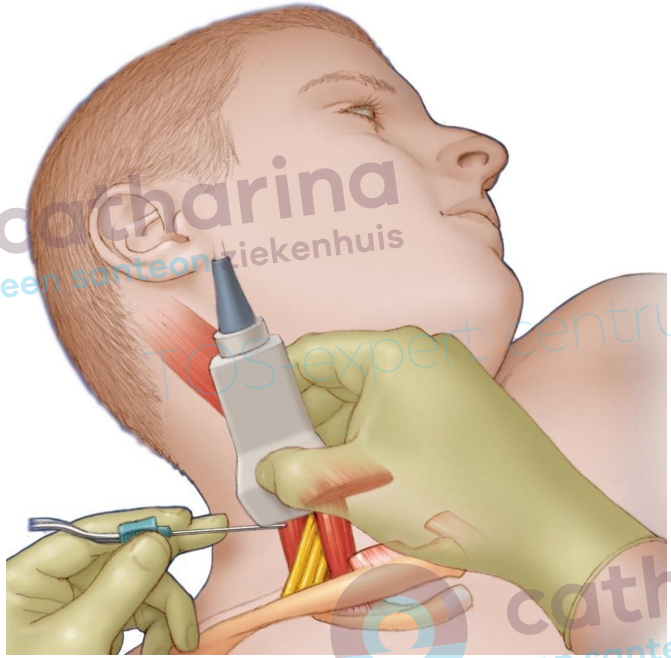
Figure 1b: median scores with interquartile range of the cervical brachial score questionnaire at baseline, 12 and 24 months. *Note: EDX = electrodiagnostic (specific for NTOS). Wilcoxon signed-rank test between baseline and follow-up interval in with deviations group: 12 months p<0.001, 24 months P=0.003. Wilcoxon signed-rank test between baseline and follow-up interval in without*

4. EMG

- **TOS**
  - Medial Antebrachial Cutaneous (MABC) sensory nerve potential gedaald
  - EMG Afwijkend bij +- 40% van NTOS patiënten
    - Aspecifieke bevindingen!
  - Rol: vnl uitsluiten van neurologische pathologie
  - DD Neuralgische amyotrofie(NA) – Carpal Tunnel – Cubitaal tunnel syndroom

5. Proefblok

- **Alle patienten onder verdenking NTOS**
  - Objectieve meting
    - Gestandardiseerde east voor en na proefblock
    - Positief = meer dan 50% toename
  - Subjectief: Likert schaal
    - Na block
    - 24h na block
  - Diagnostisch hulpmiddel
  - Goede patientenselectie operatieve behandeling?



5. Proefblok

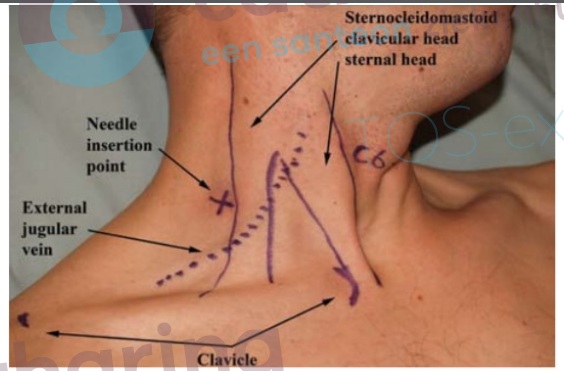


Figure 7-4

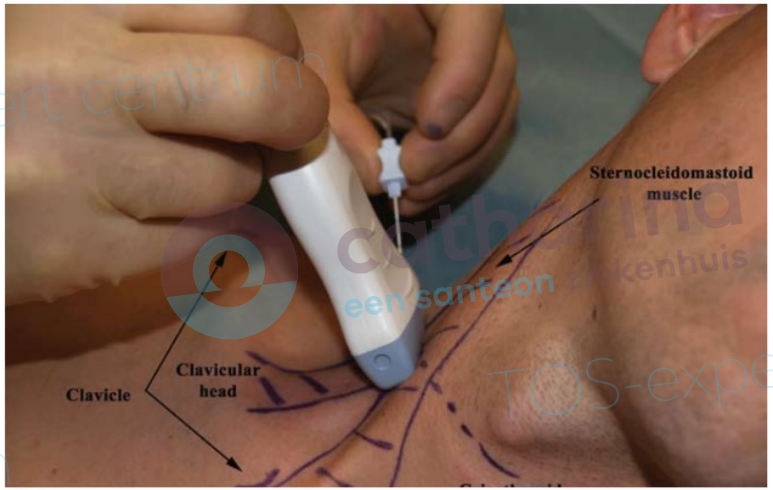
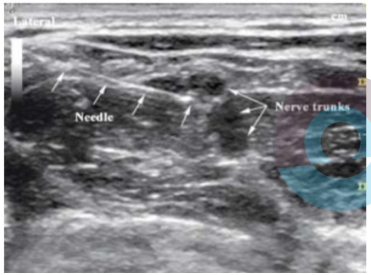


Figure 7-6



5. Proefblok

Eigen onderzoek CZE:

- The Odds Ratio (OR) een goed resultaat is 2.05; CI 1.07-3.90 wanneer patiënten een positief proefblok hadden vergeleken met een negatief proefblok.

- Echter: rol van
  - Beenderige afwijkingen
  - Fibromusculaire bandjes
  - … ?

6. MRI plexus

- MRI is in staat om compressie van de plexus op te zoeken
- Sensitiviteit & specificiteit = ??
  - Kleine studies
  - Patiëntenpopulatie = ?

6. MRI plexus

Thoracic Outlet Syndrome: Diagnostic Accuracy of MRI

Alexandre Hardy[a,b,*], Cécile Pougès[c], Guillaume Wavreille[d], Hélène Behal[b,e], Xavier Demondion[b,f,g], Guillaume Lefebvre[b,f]

Table 2
Sensitivity, specificity, positive predictive value, and negative predictive value of MRI for diagnosing sources of compression in thoracic outlet syndrome.

	Seen by MRI	Seen during surgery	TP	FN	TN	FP	Sensitivity %	Specificity %	PPV	NPV
Bands	10	36	10	26	12	0	28 [95%CI, 13-42]	100	100	32
Cervical rib	3	3	3	0	45	0	100	100	100	100
Hypertrophic vertebral process	0	0	0	0	48	0		100		100
Abnormal clavicle/rib	0	2	0	2	45	0		100		96
Anterior scalene hypertrophy	25	26	21	5	18	4	81 [95%CI, 65-95]	82 [95%CI, 65-97]	84	78
Fibrous anterior scalene	1	26	0	26	21	1		95 [95%CI, 86-100]		45
Middle scalene hypertrophy	13	33	13	20	15	0	39 [95%CI,22-56]	100	100	43
Fibrous middle scalene	0	11	0	11	37	0		100		77
Accessory muscle	4	8	4	4	40	0	50 [95%CI,15-84]	100	100	90
Subclavius muscle hypertrophy	7	3	3	0	41	4	100	91 [95%CI, 82-91]	43	100
Pectoralis minor hypertrophy	4	1	1	0	44	3	100	94 [95%CI, 86-100]	25	100
Compression by coracoclavicular ligament	0	6	0	6	42	0		100		87

TP: true positive; FN: false negative; TN: true negative; FP: false positive; PPV: positive predictive value; NPV: negative predictive value; 95%CI, 95% confidence interval.

6. MRI plexus

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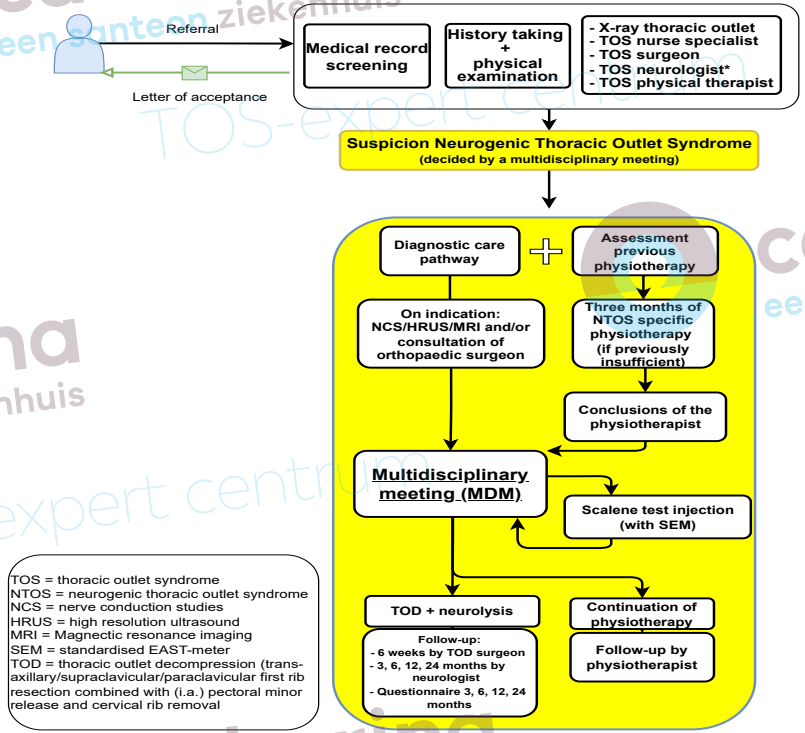
6. MRI plexus

- MRI is in staat om compressie van de plexus op te zoeken
- Sensitiviteit & specificiteit = ??
  - Kleine studies
  - Patiëntenpopulatie = ?
- MRI is in staat om dingen te missen
- Is de afwijking op MRI de oorzaak van het probleem?
- MRI = vnl om andere pathologie uit te sluiten

Validatie van het NTOS zorgpad



Validatie van het NTOS zorgpad

European Journal of Vascular and Endovascular Surgery
Volume 61, Issue 6, June 2021, Pages 1017-1024

Feasibility and Outcomes of a Multidisciplinary Care Pathway for Neurogenic Thoracic Outlet Syndrome: A Prospective Observational Cohort Study

Niels Pesser [a, f], Jens Goeteyn [a, f], Lieke van der Sanden [a], Saskia Houterman [b], Nens van Alfen [c], Marc R.H.M. van Sambeek [a, d], Bart F.L. van Nuenen [a], Joep A.W. Teijink [a, f]

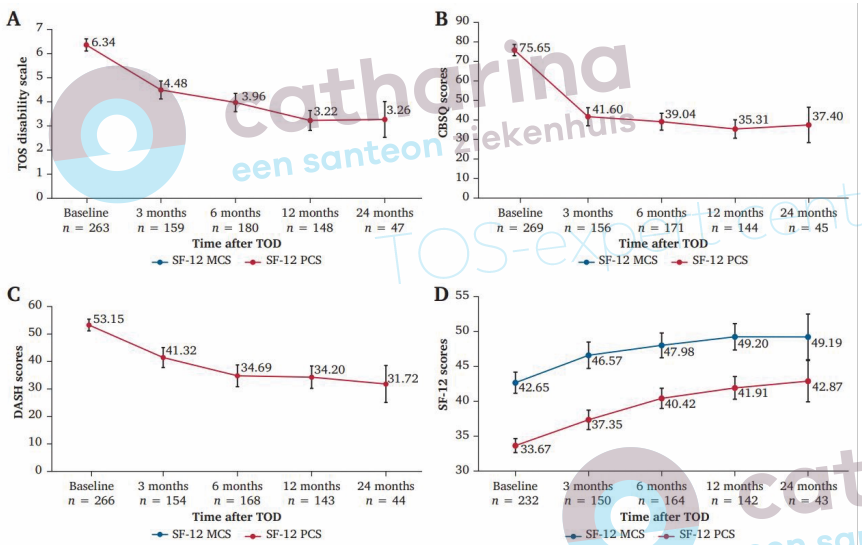
Table 1: Patient characteristics following the North American SVS-reporting standards TOS of patients treated by thoracic outlet decompression surgery. *(Continued)*

Patient characteristics	n = 274 (100%)
- Direct impact on the arm % of n=151	13 (8.6%)
- Fall (from height) % of n=151	77 (51.0%)
- Whiplash trauma % of n=151	46 (30.5%)
- Other % of n=151	15 (9.9%)
Repetitive motion injury, % of n=155	4 (2.6%)
Occupation relevant for NTOS (repetitive motion, arms overhead)	105 (38.3%)
Incapacitated for work due to complaints	113 (41.2%)
Underwent physiotherapy prior to presentation	227 (82.8%)
Underwent therapy (other than physiotherapy)	199 (72.6%)
Daily use of opioids and/or tricyclic antidepressants	68 (24.8%)
Signs of a Gilliatt-Sumner hand	14 (5.1%)
Tinel's sign over MSA/MSM positive	206 (75.2%)
Tenderness over scalene muscle	241 (88.0%)
Tenderness over pectoral minor muscle	163 (59.5%)
Elevated Arm Stress Test (EAST) positive	223 (81.4%)
Upper Limb Tensions Test (ULTT) positive	234 (85.4%)
Scalene test muscle block	
Positive	187 (68.2%)
Negative	69 (25.2%)
Not performed (Gilliatt-Sumner hand, ATOS, VTOS)	18 (6.6%)
Scalene muscle block patient-reported outcome, n=256	
Positive response % of n=256	232 (90.6%)
Negative response % of n=256	24 (9.4%)
Baseline scores	
TOS disability scale	6.34 (±2.08)
Cervical Brachial Score Questionnaire (CBSQ)	75.65 (±24.07)
Disability of the Shoulder, Arm and Hand (DASH)	53.15 (±17.72)
Short Form 12 physical scale (SF-12 PCS)	33.67 (±7.83)
Short Form 12 mental scale (SF-12 MCS)	42.65 (±11.74)

Note: SD = standard deviation, NTOS = neurogenic thoracic outlet syndrome, IQR = interquartile range, MSA = musculus scalenus anterior, MSM = musculus scalenus medius, ATOS = arterial thoracic outlet syndrome, VTOS = venous thoracic outlet syndrome.

Validatie van het NTOS zorgpad

- **Figure 2. (A) Thoracic Outlet Syndrome (TOS) disability scale; (B) Cervical Brachial Score Ques- tionnaire (CBSQ) scores; (C) Disability of the Arm, Shoulder and Hand (DASH) scores (Dutch language version); and (D) Short Form-12 (SF-12) Physical Composite Scale (PCS) and Mental Component Summary (MCS) scores of 290 patients with thoracic outlet decompression (TOD) with neurogenic thoracic outlet syndrome during follow up at three, six, 12, and 24 months. Confidence interval: standardized error of the mean. All differences between consecutive time points were statistically significant p <.001**



Validatie van het NTOS zorgpad

RANDOMISED CLINICAL TRIAL

Surgery Versus Continued Conservative Treatment for Neurogenic Thoracic Outlet Syndrome: the First Randomised Clinical Trial (STOPNTOS Trial)☆

Jens Goeteyn [a], Niels Pesser [a], Saskia Houterman [b], Marc R.H.M. van Sambeek [a,c], Bart F.L. van Nuenen [d], Joep A.W. Teijink [a,e,*]

[a] Department of Vascular Surgery, Catharina Hospital, Eindhoven, The Netherlands
[b] Department of Education and Research, Catharina Hospital, The Netherlands
[c] Department of Biomedical Technology, University of Technology Eindhoven, Eindhoven, The Netherlands
[d] Department of Neurology, Catharina Hospital, Eindhoven, The Netherlands
[e] CAPHRI School for Public Health and Primary Care, Faculty of Health, Medicine and Life Sciences, Maastricht University, The Netherlands

WHAT THIS PAPER ADDS

There have always been doubts over whether surgery for neurogenic thoracic outlet syndrome (NTOS) is useful. In this first randomised clinical trial, the effects of surgery were compared with continued conservative treatment for patients with NTOS. A clear benefit was found for surgery over continued conservative treatment. These results offer perspective for patients with NTOS that has not improved after conservative treatment. A multicentre randomised controlled trial should be the next step to validate these results.

Validatie van het NTOS zorgpad

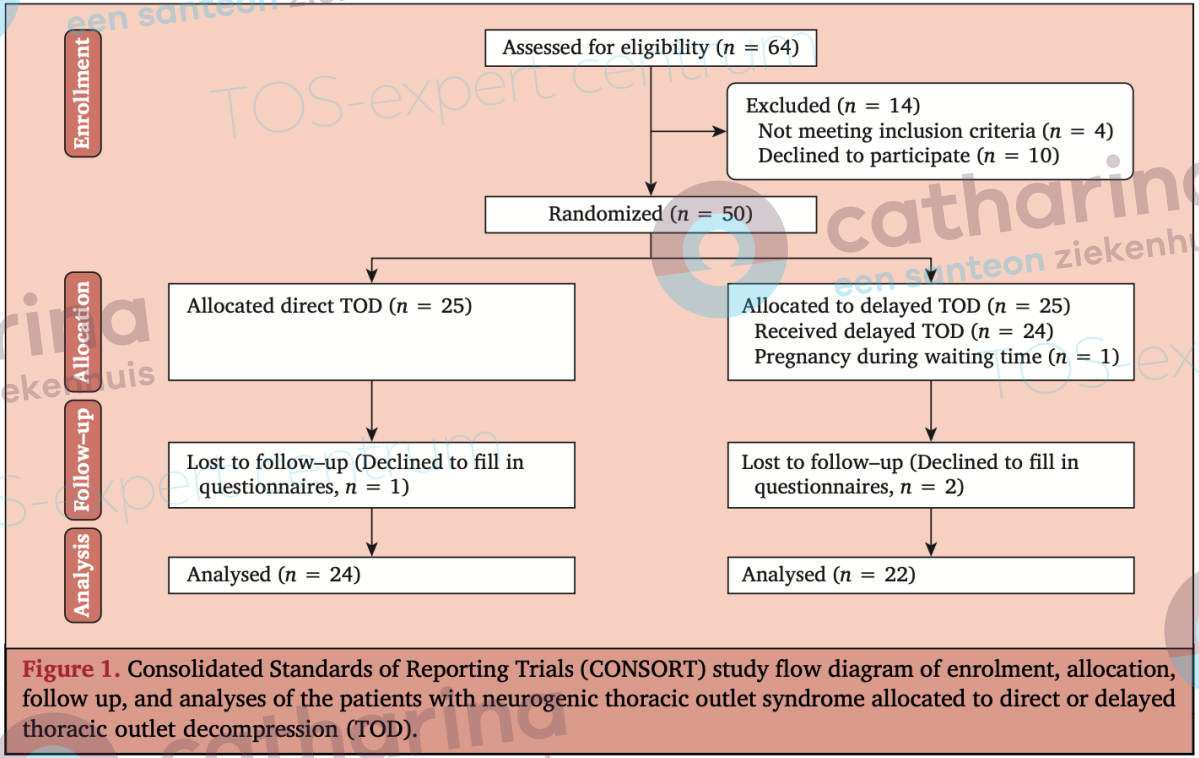
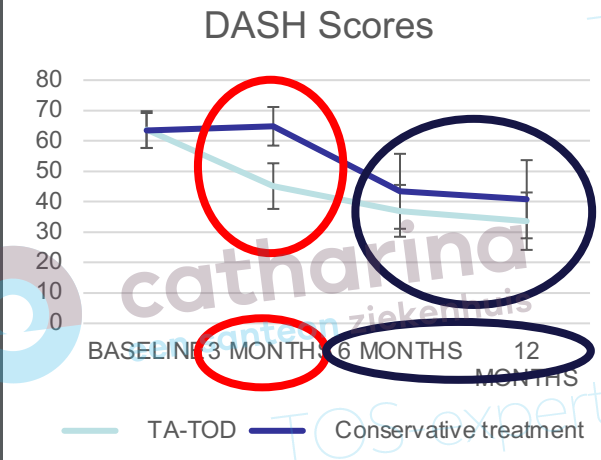
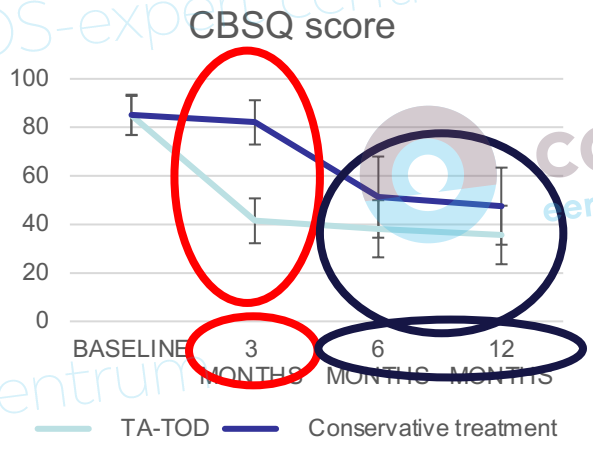
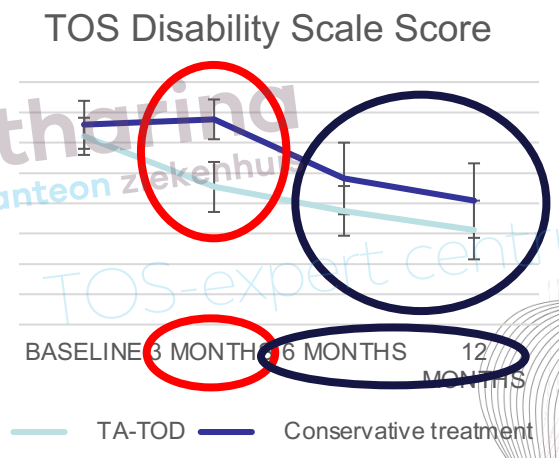


Figure 1. Consolidated Standards of Reporting Trials (CONSORT) study flow diagram of enrolment, allocation, follow up, and analyses of the patients with neurogenic thoracic outlet syndrome allocated to direct or delayed thoracic outlet decompression (TOD).

Validatie van het NTOS zorgpad







At 3 months after randomization there was a statistically significant difference between both TA-TOD group and conservative treatment group for the DASH, CBSQ and TOS Disability Scale scores. (p<0.001).

At twelve months after randomization, no statistically significant difference was found. (p= 0.42 for DASH, p=0.25 for CBSQ and P=0.33 for TOS Disability Scale. No statistically significant differences were found for quality of life (PCS and MCS).

Validatie v

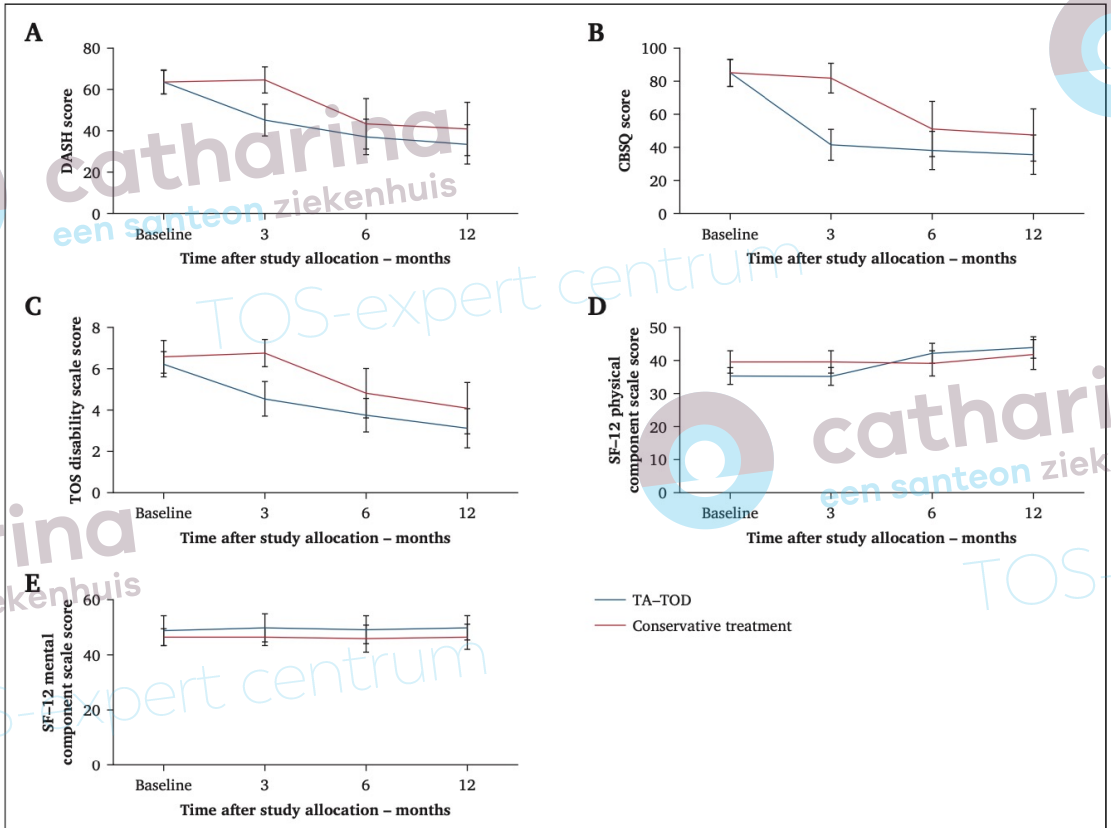


Figure 2. (A) Disability of the Arm, Shoulder and Hand (DASH) scores, (B) Cervical Brachial Score Questionnaire (CBSQ) scores, (C) Thoracic outlet syndrome (TOS) disability scale, (D) Short Form-12 (SF-12) Physical Composite Scale (PCS), and (E) Mental Component Summary (MCS) scores for 24 patients undergoing transaxillary thoracic outlet decompression (TA-TOD) and 22 patients with conservative treatment during follow up at baseline, three, six, and 12 months after randomisation. Three months after randomisation, the differences between the TA-TOD group and conservative treatment group for the DASH, CBSQ, and TOS disability scale scores were statistically significant ($p < .001$). Twelve months after randomisation, no statistically significant differences were found ($p = .42$ for DASH, $p = .25$ for CBSQ, and $p = .33$ for TOS disability scale). In repeated measures of ANOVA with adjustment for multiple comparisons (Bonferroni) taking all time points into account, statistically significant differences were found comparing TA-TOD with the conservative treatment group ($p = .002$ for DASH, $p < .001$ for CBSQ, and $p < .001$ for TOS disability scale). No statistically significant differences were found for quality of life (PCS and MCS). Confidence interval = standardised error of the mean.

CONCLUSIE

- **De rol van aanvullende beeldvorming bij diagnose van NTOS is dubieus**
  - Duplex heeft geen meerwaarde
  - EMG is aspecifiek
  - HRUS bevestigt alleen het klinisch beeld (GSH)
  - Lichamelijk onderzoek is aspecifiek
  - sEAST kan het effect van een proefblok objectiveren
  - De waarde van het proefblok is onvoldoende geobjectiveerd in wetenschappelijke literatuur

- **De diagnostische onderzoeken zijn vooral van belang om andere aandoeningen uit te sluiten.**
- **Diagnostiek op indicatie!!**