35th SITEMSH congress

The prevalence and characteristics of TOS in high school baseball players

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Thoracic Outlet Syndrome (TOS)

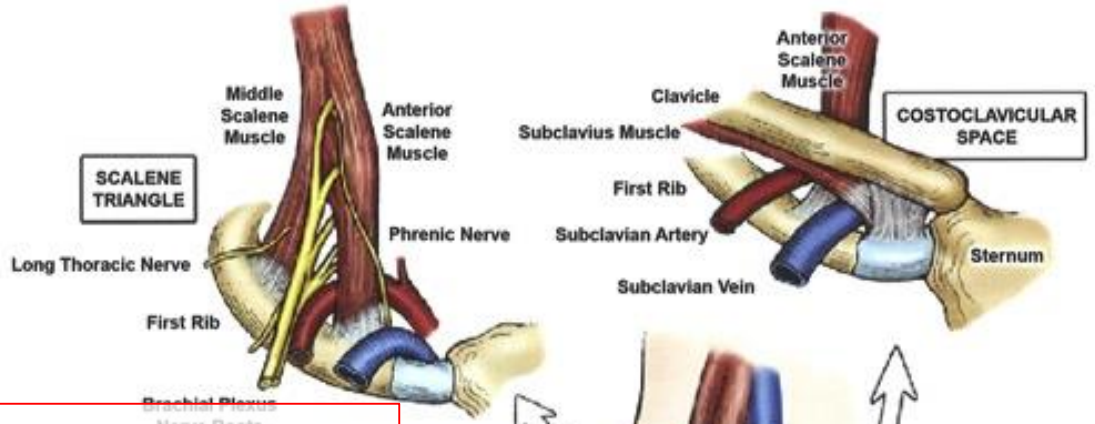
A set of symptoms that may exist due to the compression on the brachial plexus and on sub-clavian vessels in the region of the thoracic outlet.

Peet RM et al. Mayo Clin Proc 1956
Rodd CG et al. Ann Surg 1966

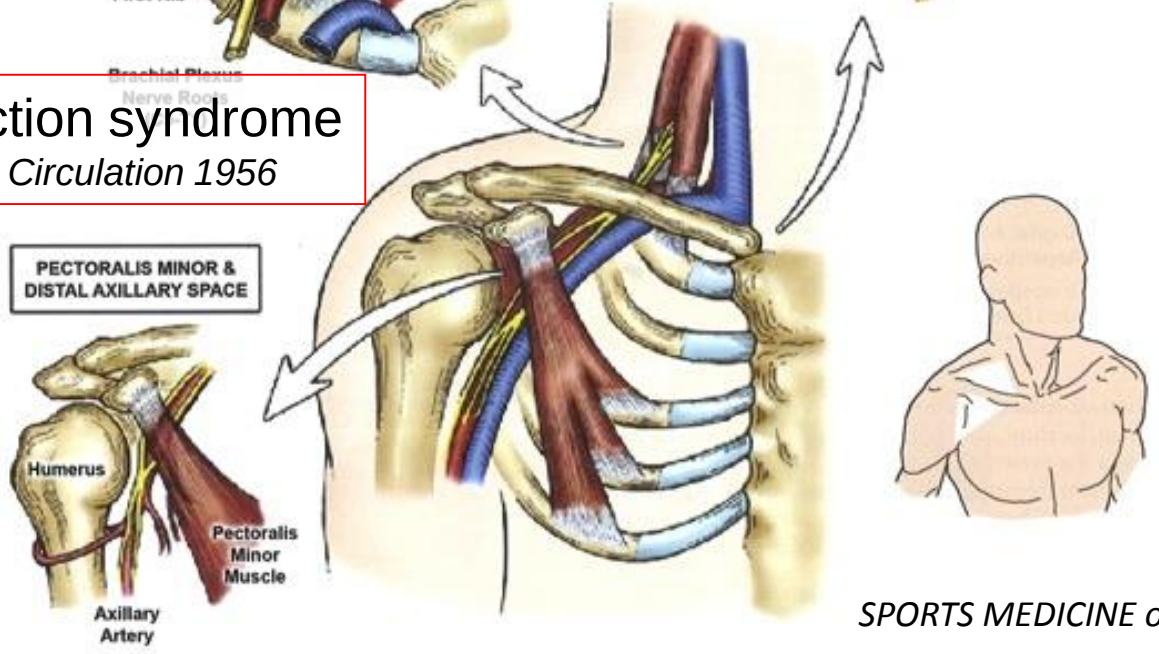
Anatomy of Thoracic Outlet

Scalenus anticus syndrome
Ochsner A et al. Am J Surg 1935

Costoclavicular syndrome
Telford ED et al. Br Med J 1947



Hyper-abduction syndrome
Lord JW et al. Circulation 1956



Classification of TOS

- ✓ *Neurogenic*

- ✓ *Arterial*

  Thromboenbolism, Vasospasm, Digital ischemia, Aneurysms

- ✓ *Venous*

  Effort Thrombosis (Paget-Schroetter syndrome)

Hempel GK et al. Ann Vasc Surg. 1996
Sanders RJ et al. Semin Thorac and Cardiovasc Surg.1996
Sanders RJ et al. Surg Gynecol Obstet. 1991

Causes of TOS

- ✓ *Osseous or soft tissue abnormality*
- ✓ *Trauma*
- ✓ *Poor posture*
- ✓ *Occupational factor*
- ✓ *Athletic factor*

Archer

Park JY et al. CORR 2013

Rower

Strukel RJ et al. AJSM 1978

Swimmer

Katirji B. Musk Nerve 1995
Richardson AB. CSM1999

Wrestler

Karageanes SJ CJSM 1998

Baseball player

Reports of TOS in MLB Players

- operated cases -

venous

Aaron Cook 2004

Jeremy Bonderman 2008

arterial

J.R. Richard 1980

Whitey Ford 1966

Dennis "Oil Can" Boyd 1987

Kip Wells 2006,2008

David Cone 1996

Kenny Rogers 2001

Roberto Hernandez 1991

Derek Wallace 1997

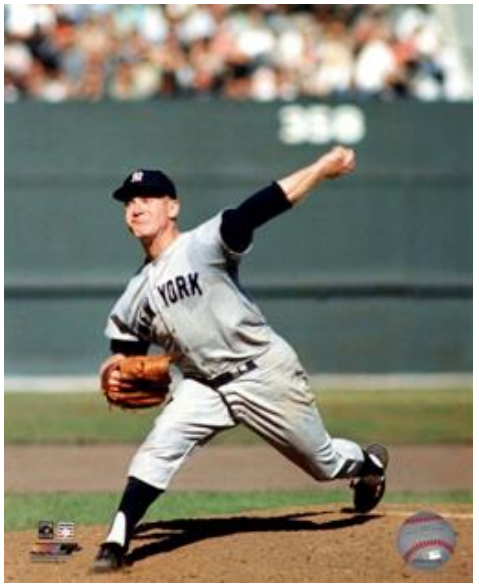
Felix Heredia 2005

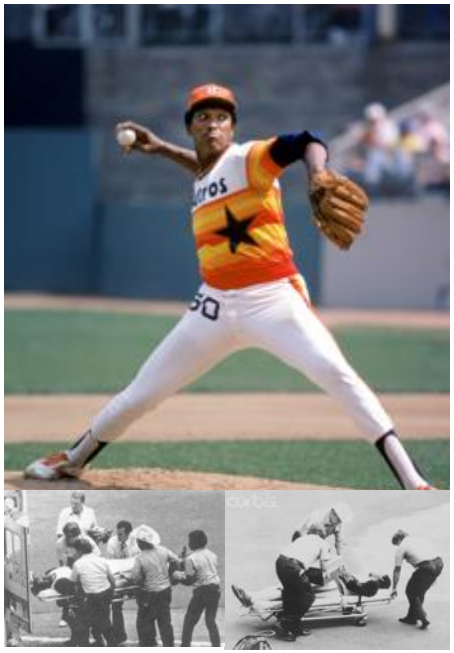
Ian Kennedy 2009

Rich DeLucia 1997

Cocker WL, BASEBALL INJURY
Case studies, by type, in the Major League

Whitey Ford
CORR 1972





J.R. Richard
Harold Klawans' Book

David Cone
J Vasc Surg 1998

Reports of TOS in Japanese Baseball Players

Venous
Yamaguchi et al. 2013
Higuchi et al. 2008
Endo et al. 2007
Uchida et al. 2006
Kinoshita et al. 2006

Arterial
Niwayama et al. 2013
Okamoto et al.1998
Uranaka et al. 1998
Motoya et al. 1996
Akiyama et al. 1991
Usui et al. 1985

Neurogenic
Koga et al. 2014
Itoh et al. 2013
Iwahori et al. 2013
Otoshi et al. 2011
Tsujino et al. 2009
Oishi et al. 2001
Morisawa et al. 1998
Abe et al. 1989

Association Between TOS and Upper Extremity Pain

- ✓ *5.3-8.1% of overhead athletes who visit hospital with shoulder and elbow injuries have symptoms of TOS.*
  Iwahori Y et al. The Shoulder Joint 2013
  Furushima K et al. 2014

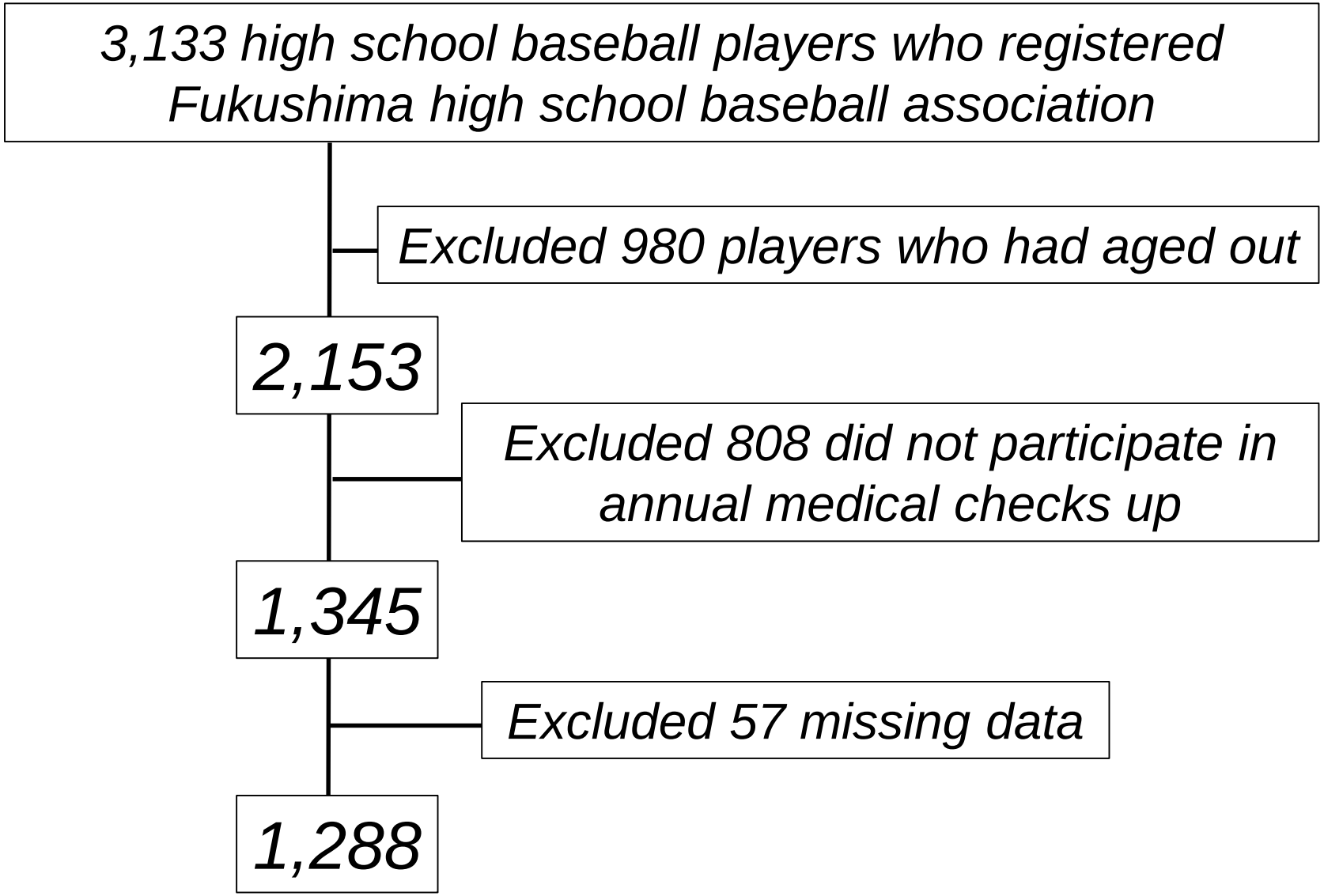
- ✓ *Approximately 70% of baseball players who received 1st rib resection for TOS complained of shoulder and elbow pain before surgery.* *Otoshi K et al. Jpn.J.Orthop. Sports Med 2011*

A large number of baseball players may have signs and symptoms of TOS

Purpose

1. *To investigate the prevalence of TOS in baseball players*
2. *To investigate the association between TOS and shoulder and elbow pain*

Study Flow Chart



Materials and Methods

Self completed questionaire	✓ *Experience of TOS symptoms in throwing arm (heaviness, numbness, fatigue, coldness)* ✓ *Experience of shoulder and elbow pain over the past 1 year*
Physical findings	✓ *Abduction External Rotation Test (Roos test)* *Roos DB. Am J Surg. 1976* ✓ *Shoulder and elbow pain in MER position*

Abduction External Rotation Test (Roos test)

Roos DB. Am J Surg. 1976

Variations of induced symptoms, affected side, and symptom severity was assessed.

Our Criteria for TOS

- ✓ *Positive Roos test in throwing arm*
- ✓ *Experience of symptoms in throwing arm in the past*

Results

Results$_{1\text{-}1}$
Experiences of Symptoms in Throwing Arm

No experience of symptoms			
			666 (51.7%)
Experience of symptoms			
			622 (48.3%)
heaviness	*403 (31.3%)*	*fatigue*	*164 (12.7%)*
nubness	*386 (30.0%)*	*coldness*	*113 (8.8%)*
	Total		***1288 (100%)***

Result$_{1\text{-}2}$

Variations of Induced Symptoms by Roos Test

Negative Roos test			
			280 (21.7%)
Positive Roos test			
			1008 (78.3%)
heaviness	*636 (49.4%)*	*fatigue*	*114 (8.9%)*
nubness	*278 (21.6%)*	*coldness*	*57 (4.4%)*
hotflash	*193 (15.0%)*	*others*	*27 (2.1%)*
Pain	*130 (10.1%)*		
Total			***1288 (100%)***

Result$_{1\text{-}3}$
Affected Side of Roos Test

Negative Roos test	
	280 (21.7%)
Positive Roos test	
	1008 (78.3%)
Throwing arm only	*327 (25.4%)*
Non-throwing arm only	*163 (12.7%)*
Bilateral arm	*518 (40.2%)*
Total	***1288 (100%)***

Result$_{1\text{-}4}$
Sustainable time to continue the Roos Test

Negative Roos test	
	280 (21.7%)
Positive Roos test	
	1008 (78.3%)
< 15 sec	*60 (4.7%)*
15–30 sec	*381 (29.6%)*
30 sec <	*567 (44.0%)*
Total	***1288 (100%)***

Results$_{2\text{-}1}$
The Prevalence of TOS

Negative Roos test	
	280 (21.7%)
Positive Roos test	
	1008 (78.3%)

	Experience of symptoms in the past	
	Negative(n=511)	*Positive(n=497)*
Non-throwing arm only	*88 (6.8%)*	*75 (5.8%)*
Throwing arm only	*137 (10.6%)*	*190 (14.8%)*
Bilateral arms	*286 (22.2%)*	*232 (18.0%)*
Total		***1288 (100%)***

Results$_{3\text{-}1}$
Association between TOS and Shoulder Pain

		TOS		
		Negative n=866	*Positive n=422*	*Relative risk*
Shoulder pain previous 1 year	*Experience*	*335 (38.7%)*	*217 (51.4%)*	*1.3**
	Recurrence	*169 (19.6%)*	*150 (35.6%)*	*1.8**
	Disability	*199 (23.1%)*	*132 (31.3%)*	*1.4**
Shoulder pain in MER position		*82 (9.5%)*	*85 (20.1%)*	*2.1**

**P<0.05*

Results$_{3\text{-}2}$
Association between TOS and Elbow Pain

		TOS		
		Negative n=866	Positive n=422	Relative risk
Elbow pain previous one year	experience	383 (44.2%)	259 (61.4%)	1.4*
	Recurrence	232(26.9%)	190 (45.2%)	1.7*
	Disability	204 (23.8%)	159 (38.0%)	1.6*
Elbow pain in MER position		55 (6.4%)	64 (15.2%)	2.4*

*P<0.05

Discussion

Discussion$_{1\text{-}1}$
Prevalence of TOS in Baseball Players

Working population

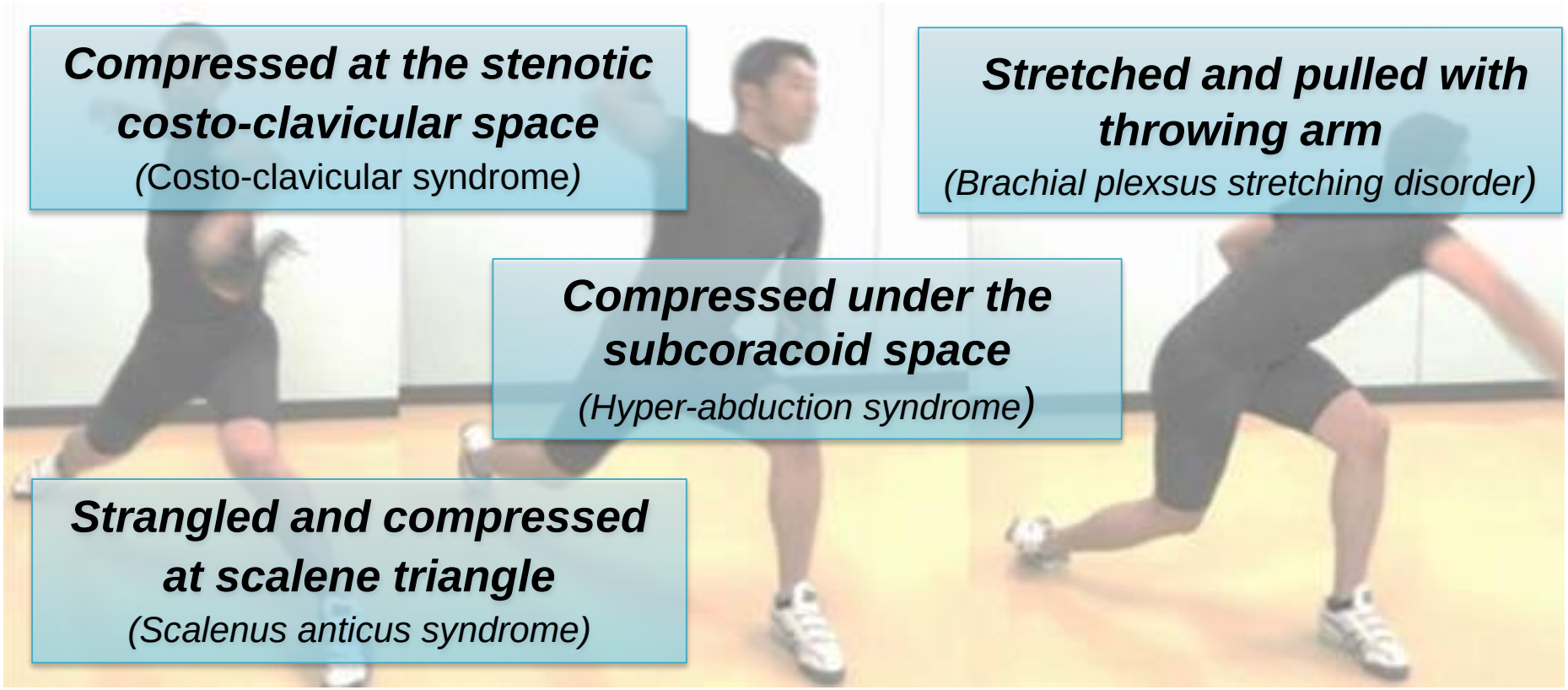
- ✓ *30 young male soldiers and 33 female nursing students* — *Sällström J. Clin Physiol. 1982* — *9.5%*
- ✓ *191 workers* — *Sällström J. Am J Ind Med.1984* — *18%*

Overhead throwing athletes

- ✓ *1288 high school male baseball players* — *Our study* — *32.8%*

Throwers may be at high risk of TOS

Discussion$_{1\text{-}2}$
Dynamic Factors of TOS in Throwing



Neurovascular structures may be vulnerable to compression or stretching by throwing

Discussion$_{2\text{-}1}$
Interpreting the Roos Test Results

40.2% of players had induced bilateral arm symptoms by Roos test

Non-throwing arm only	*163 (12.7%)*
Throwing arm only	*327 (25.4%)*
Bilateral arms	*518 (40.2%)*

Underlying vulnerability of neurovascular structure (e.g., bilateral anatomical abnormalities) is suspected

Discussion$_{2\text{-}2}$
Possible Causes of Bilateral TOS Symptoms

Congenital factors

- ✓ *Cervical rib* — *Kaminski SB et al. Sports Med Arthrosc Rev 2000*
- ✓ *Fibrous band* — *Roos DB. AJSM 1976*
- ✓ *Muscle abnormalities*
  - *Scalene muscle* — *Swank RL et al. Arch Neurol Psych 1944*; *Adson AW. J Int Coll Surg 1951*
  - *Pectoralis minor muscle* — *Simovtich RW et al. AJSM 2006*
  - *Subclavian muscle* — *Hasan SS et al. Orthopaedics 2001*

Acquired factors

- ✓ *Hypertrophy of scalene and pectoralis minor muscle* — *McCarthy WJ et al. J Vasc Surg 1989*

Discussion$_{3\text{-}2}$
How Does TOS Increase Pain Risk?

Compression of neurovascular structures in the region of the thoracic outlet

Axonal flow disturbance and the disruption of the neurofilament architecture

Blood flow disturbances induced by vascular occlusion

Vulnerability of peripheral nerve to compression (Double Crush Syndrome)

- ✓ *Axially nerve*
- ✓ *Ulnar nerve*
- ✓ *Radial nerve (PIN)*
- ✓ *Median nerve*

Exacerbating the nociceptive pain (Hypersensitivity)

- ✓ *Shoulder impingement*
- ✓ *MUCL injury*
- ✓ *Other throwing injuries*

Induced Ischemia of upper extremity (Ischemic pain)

- ✓ *Digital ischemia*
- ✓ *Arterial thrombosis*
- ✓ *Effort thrombosis*

Limitations of This Study

- ✓ *TOS is defined only by the self-reported symptoms and Roos test.*
- ✓ *Did not compare the prevalence in baseball players to that in general population and the players engaged in other sports using same criteria.*
- ✓ *Confounding factor was not adjusted in assessing the association between TOS and upper extremity pain.*

Conclusion

- ✓ *The prevalence of TOS in high-school baseball player was 32.8%*
- ✓ *Players with TOS was significantly at high risk of shoulder and elbow pain compared with those without.*
- ✓ *It should be necessary to recognize that TOS is not rare pathology in overhead throwing athletes.*

Thank you for your attention !