Chris Warrell, MD Orthopaedic Sports Medicine Orlando Orthopaedic Center February 3, 2018



## **Official Collegiate Team of OOC!**





### Outline

- When to be concerned
- Evaluation and work-up
  - Imaging
  - Electrodiagnostic studies
- Treatment
- Rehabilitation
- Return to Play
- When to disqualify / retire
- Controversies





### Outline

- When to be concerned
- Evaluation and work-up
  - Imaging
  - Electrodiagnostic studies
- Treatment
- Rehabilitation
- Return to Play
- When to disqualify / retire
- Controversies
  - Very little high level evidence





#### When To Be Concerned

- Symptoms lasting > 48hrs
- Anything indicating a higher lesion
  - Persistent neck pain,

bilateral symptoms, loss of neck ROM, lower extremity

symptoms

• Two or more stingers in a season





### Epidemiology

- Only 5-10% stingers persist more than a few hours
- Brachial plexus injuries and anatomic anomalies more common in younger (high school) athletes
- Cervical spine level injuries (esp. disc herniation) more common in collegiate/pro athletes



Speer K. The Prolonged Burner Syndrome. AJSM 1990; 18:591-94

Levitz CL, Reilly PJ, Torg JS. The pathomechanics of chronic recurrent cervical nerve root neuropraxia. The chronic burner syndrome. AJSM 1997;25:73-6 Neyer sa, Schulte KR, Callaghan JJ, et al. Cervical spinal stenosis and stingers in collegiate football players. AJSM 1994;22:158-66



#### **Evaluation**

- As discussed by Dr. McCleary
- Serial examinations
  - Time of injury
  - After game
  - 24 48 hours later
    - Decision point for imaging
  - Repeatedly over first 2 weeks
    - Decision point for EMG/NCV



Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinstein S. Assessment and rehabilitation of an athlete with a "stinger": a model for the management of noncatastrophic athletic cervical spine injury. Clin Sports Med. 17:127-135 1998



#### Imaging

- Plain radiographs
  - AP, lateral, flexion, extension, open mouth odontoid
  - Cervical spine pathology
    - Anomalies
    - **Fractures**
    - Instability
  - If index of suspicion is high enough

#### to get xrays, get advanced imaging



Klippel-Feil Anomaly in 16 yo



Acheson M, Livingston R, Richardson M, et al.: High-resolution CT scanning in the evaluation of cervical spine fractures: comparison with plain film examinations. AJR Am J Roentgenol. 148 (6):1179-1185 1987

Nunez D, Zuluaga A, Fuentes-Bernardo D, et al.: Cervical spine trauma: how much more do we learn by routinely using helical CT? Radiographics. 16:1307-1318 1996 Bailitz J, Starr F, Beecroft M, et al.: CT should replace three-view radiographs as the initial screening test in patients at high, moderate, and low risk for blunt cervical spine injury: a prospective comparison. J Trauma. 66 (6):1605-1609 2009



#### Imaging

- Advanced imaging
  - MRI c-spine vs. CT myelogram
    - Disc herniation
    - Foraminal narrowing
    - Nerve root injury
    - Spinal canal stenosis
  - MRI brachial plexus





Acheson M, Livingston R, Richardson M, et al.: High-resolution CT scanning in the evaluation of cervical spine fractures: comparison with plain film examinations. AJR Am J Roentgenol. 148 (6):1179-1185 1987

Nunez D, Zuluaga A, Fuentes-Bernardo D, et al.: Cervical spine trauma: how much more do we learn by routinely using helical CT? Radiographics. 16:1307-1318 1996 Bailitz J, Starr F, Beecroft M, et al.: CT should replace three-view radiographs as the initial screening test in patients at high, moderate, and low risk for blunt cervical spine injury: a prospective comparison. J Trauma. 66 (6):1605-1609 2009



### Imaging

- Torg/Pavlov Ratio
  - Ratio of canal width to
    - vertebral body width
  - Should be >1.0
  - <0.8 associated with increased risk (3-4x) of transient neurologic injury in contact athletes





Torg J, Pavlov H, Genuario S, et al. Neurapraxia of the cervical spinal cord with transient quadriplegia. JBJS Am. 1986;68:1354-70 Torg J, Corcoran T, Thiboult L, et al. Cervical cord neurapraxia classification, pathomechanics, morbidity, and management guidelines. J Neurosurg. 1997;87:843-50 Meyer S, Schulte K, Callaghan, et al. Cervical spinal stenosis and stingers in collegiate football players. AJSM 1994;22(2):158-66



### Imaging

- Torg/Pavlov Ratio
  - Not predictive of single stinger (PPV 22%)
    - Poor for screening
  - Significant risk factor for repetitive stingers





Castro F, Ricciardi J, Brunet M, et al. Stingers, Torg ratio, and the cervical spine. AJSM. 1997;25:603-8 Page S, Guy J. Neurapraxia, "stingers" and spinal stenosis in athletes. South Med J. 2004;97(8):766-9

Herzog R, Wiens J, Dillingham M, et al. Normal cervical spine morphometry and cervical spinal stenosis in asymptomatic professional football players: plain radiography, multiplanar CT and MRI. Spine. 1991;16:S178-86



#### Imaging

- Mean Subaxial Cervical Space
  Available for the Cord (MSCSAC)
  Index
  - <5.0mm has 80% PPV for

predicting chronic stingers

 <4.3mm has 96% PPV (13x more likely)



	Diameter, mm		
Level	Canal	Cord	Difference, ∆
СЗ	11.2	7.8	3.4
C4	10.3	7.8	2.5
C5	10.3	7.8	2.5
C6	11.4	7.0	4.4
Average			3.2

Greenberg J, Leung D, Kendal J. Predicting chronic stinger syndrome using the mean subaxial space available for the cord index. Sports Health. 2011;3(3):264-7 Presciutti SM, DeLuca P, Marchetto P., et al. Mean subaxial space available for the cord index as a novel method of measuring cervical spine geometry to predict the chronic stinger syndrome in American football players. J Neurosurg Spine. 2009;11(3):264-71



### **Electrodiagnostic Studies**

- Electromyography (EMG) and Nerve conduction studies
- Obtain 3-5 weeks after injury
  - Maximal evidence of
    - muscle denervation
      - Follows Wallerian
        (distal) degeneration of the nerve



Fibrillation Potentials









Distal latency (ms)

Proximal latency (ms)

Wilbourn A. Electrodiagnostic testing of neurologic injuries in athletes. Clin Sports Med. 1990;9:229-45



### **Electrodiagnostic Studies**

• Can help determine *severity* of the injury

Grade	Nerve Injury	Electromyographic Findings	Prognosis
1	Neurapraxia	Normal	Most resolve within minutes
2	Axonotmesis	Positive waves with fibrillation	Recovery in 12-18 months
3	Neurotmesis	Acute denervation	Variable; possible complete loss of function

**Fibrillation Potentials** 

Positive Sharp Waves





### **Electrodiagnostic Studies**

• Can help determine *severity* of the injury





### **Electrodiagnostic Studies**

- Can help determine *location* of the injury
  - Preganglionic: Involvement of rhomboids, serratus, cervical paraspinals; sensory nerve action potentials (SNAPs) preserved
  - <u>Postganglionic</u>: spares above

#### muscles; SNAPs disrupted

Wilbourn A. Electrodiagnostic testing of neurologic injuries in athletes. Clin Sports Med. 1990;9:229-45





### **Electrodiagnostic Studies**

- Can help *monitor recovery* 
  - Serial examinations
- Cannot reliably determine return to play
  - Electrical abnormalities can persist for months/years after resolution of



symptoms



#### Treatment

- Grade I & II
  - Nonoperative
  - Spontaneous recovery
    - Nerve regenerates
      - ~1 mm/day, 1

#### inch/month

Physical therapy &

#### rehabilitation

Grade	e Nerve Prognosis Injury		
1	Neurapraxia	Most resolve within minutes	
2	Axonotmesis	Recovery in 12-18 months	
3	Neurotmesis	Variable; possible complete loss of function	



Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Vaccaro A, Klein G, Ciccoti M, et al.: Return to play criteria for the athlete with cervical spine injuries resulting in stinger and transient quadriplegia/paresis. Spine.2002;2:351-356 Cantu R: Stingers, transient quadriplegia, and cervical spinal stenosis: return to play criteria. Med Sci Sports Exerc. 1997;29:S233-S235 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500



### Rehabilitation

- Restore cervical spine ROM
- Cervical spine strengthening
- Restore upper extremity ROM, strengthening
- Functional rehabilitation
- Sport specific rehabilitation





#### Treatment

- Grade III
  - Typically require surgery as guided by imaging,

#### EMG/NCV

- Nerve repair
- Nerve graft
- Nerve transfer

Grade	Nerve Injury	Prognosis	
1	Neurapraxia	Most resolve within minutes	
2	Axonotmesis	Recovery in 12-18 months	
3	Neurotmesis	Variable; possible complete loss of function	



Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfer and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS Am. 2011;93(9):819-29



#### Treatment

- Grade III
  - Nerve graft
    - Typically postganglionic
    - Donor nerve to bridge gap
      - Sural
      - Med. brachial cutaneous
      - Med. antebrachial

#### cutaneous



Pieces of donor nerve taken from leg are used to fill the gap in the injured nerve



Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfer and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS Am. 2011;93(9):819-29



#### Treatment

- Grade III
  - Nerve transfer
    - Transfer nearby, functional,
      noncritical nerve (in part or whole) to critical

nonfunctioning nerve

- Faster, superior reinnervation
- Initially described for elbow

#### flexion (Oberlin procedure)



#### Principles of Motor Nerve Transfers

- Donor nerve near target motor end plates
- Expendable donor nerve
- Pure motor donor nerve
- Donor-recipient size match
- Donor function synergy with recipient function
- Motor re-education improves function

Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfer and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS Am. 2011;93(9):819-29 Mackinnon SE, Novak CB, Nerve transfers. New options for reconstruction following nerve injury. Hand Clin 1999;15(4):643-66



#### Treatment

- Grade III
  - Nerve transfer
    - Indications have expanded for nearly every

#### motor/sensory function in the upper limb

Patsy	Donor	Recipient	
C5, 6	Spinal accessory Radial (long head of triceps) Ulnar fascicle Median fascicle	Suprascapular Axillary (anterior) Biceps branch Brachialis branch	
C5, C6, C7	Spinal accessory Intercostals Ulnar fascicle Median fascicle	Suprascapular Axillary (anterior) Biceps branch Brachialis branch	
C8, T1	Brachioradialis or brachialis branch Supinator branch	AIN PIN	

Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfer and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS Am. 2011;93(9):819-29 Mackinnon SE, Novak CB, Nerve transfers. New options for reconstruction following nerve injury. Hand Clin 1999;15(4):643-66



#### Treatment

- Grade III
  - Surgery



Goodwin D, Kalantar SB. Stingers. In Delee and Drez's Orthopaedic Sports Medicine: Principles and Practice. 4<sup>th</sup> Ed. Saunders. 2015 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfer and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS Am. 2011;93(9):819-29 Mackinnon SE, Novak CB, Nerve transfers. New options for reconstruction following nerve injury. Hand Clin 1999;15(4):643-66



#### Treatment

- Grade III
  - Surgery





### **Return to Play**

- No formal published guidelines
- General requirements
  - Adequate time to heal
  - Absence of underlying condition
  - Resolution of all symptoms
  - Full, pain free ROM
  - Appropriate cardiovascular fitness
  - Normal strength
  - Ability to perform sport-specific skills

#### without symptoms

Standaert CJ, Herring SA. Expert opinion and controversies in musculoskeletal and sports medicine: Stingers. Arch Phys Med Rehabil. 2009;90(3)402-6 Cantu RC, Li YM, Abdulhamid M, et al. Return to play after cervical spine injury in sports. Curr Sports Med Rep. 2013;12(1):14-7





#### **Return to Play**

#### • Standaert et al (APMR 2009)

Event	Sequelae	Diagnostic Evaluation	Return-to-Play
1 <sup>st</sup> stinger	Rapid resolution of all symptoms (seconds to minutes) No neurologic deficits Full, pain-free cervical & shoulder ROM	None required	No contraindication
	Persisting pain, paresthesias, neurologic deficit, or limited ROM	Yes—consider plain radiographs, MRI, EDX, others as indicated	Not in same game, not until all RTP criteria met
2 <sup>nd</sup> stinger, same season	Rapid resolution of all symptoms (seconds to minutes) No neurologic deficits Full, pain-free cervical & shoulder ROM	Yes—consider plain radiographs, MRI, others as indicated	Not in same game depending upon proximity and severity
	Persisting pain, paresthesias, neurologic deficit, and/or limited ROM	Yes—consider plain radiographs, MRI, EDX, others as indicated	Not in same game, not until all RTP criteria met, consider termination of season
2 <sup>nd</sup> stinger, different season	Rapid resolution of all symptoms (seconds to minutes) No neurologic deficits Full, pain-free cervical & shoulder ROM	Yes—consider plain radiographs, MRI, others as indicated	No contra-indication
	Persisting pain, paresthesias, neurologic deficit, and/or limited ROM	Yes—consider plain radiographs, MRI, EDX, others as indicated	Not in same game, not until all RTP criteria met

Standaert CJ, Herring SA. Expert opinion and controversies in musculoskeletal and sports medicine: Stingers. Arch Phys Med Rehabil. 2009;90(3)402-6



#### **Return to Play**

#### • Standaert et al (APMR 2009)

Event	Sequelae	Diagnostic Evaluation	Return-to-Play
3 <sup>rd</sup> stinger or more, same season	Rapid resolution of all symptoms (seconds to minutes) No neurologic deficits Full, pain-free cervical & shoulder ROM	Yes—consider plain radiographs, MRI, others as indicated	Out for season, consider termination of participation in collision or contact sports
	Persisting pain, paresthesias, neurologic deficit, and/or limited ROM	Yes—consider plain radiographs, MRI, EDX, others as indicated	Out for season, consider termination of participation in collision or contact sports
3 <sup>rd</sup> stinger or more, different seasons	Rapid resolution of all symptoms (seconds to minutes) No neurologic deficits Full, pain-free cervical & shoulder ROM	Yes—consider plain radiographs, MRI, others as indicated	Not in same game depending upon proximity and severity, consider termination of season and/or participation in collision or contact sports
	Persisting pain, paresthesias, neurologic deficit, and/or limited ROM	Yes—consider plain radiographs, MRI, EDX, others as indicated	Out for season, consider termination of participation in collision or contact sports

Standaert CJ, Herring SA. Expert opinion and controversies in musculoskeletal and sports medicine: Stingers. Arch Phys Med Rehabil. 2009;90(3)402-6 Dimberg EL, Burns TM. Management of common neurologic conditions in sports. Clin Sports Med 2005;24:637-62 Weinberg J, Rokito S, Sibler J: Etiology, treatment, and prevention of athletic "stingers.". Clin Sports Med. 2003;22(3):493-500 American College of Sports Medicine. The team physician and return-to-pay issues: a consensus statement. Med Sci Sports Exerc. 2002;34:1212-4



#### **Return to Play**

- Protective equipment
  - Properly fitting shoulder pads
  - Collars
    - Recommended for RTP
      - limited supporting data
    - Limit hyperextension
    - Poor in limiting lateral flexion







Standaert CJ, Herring SA. Expert opinion and controversies in musculoskeletal and sports medicine: Stingers. Arch Phys Med Rehabil. 2009;90(3)402-6 Gorden JA, Straub SJ, Swanik CB, et al. Effects of football collars on cervical hyperextension and lateral flexion. J Athl Train. 2003;38(3):209-15 Hovis W, Limbird T: An evaluation of cervical orthoses in limiting hyperextension and lateral flexion in football. Med Sci Sports Exerc. 1994;26:872-6



### **Key Points**

• 90-95% of stingers resolve quickly



- Serial examinations for those that do not
- Obtain imaging for symptoms >24-48hrs
- Obtain EMG for symptoms >2 weeks
- Most chronic stingers treated with observation, rehab
- Grade III injuries typically require surgery
- RTP when asymptomatic, no underlying abnormalities
- Consider removal from game, ending season, terminating participation for multiple/chronic stingers
  - Particularly if anatomic, radiographic abnormality





#### **Thank You**

