Causation

Cautionary Tales From Two Common Musculoskeletal Conditions
Faculty/Presenter Disclosure

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- Relationships with commercial interests:
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Disclosure of Commercial Support

- This program has received financial support from: No Organization

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- Potential for conflict(s) of interest:

  I have received no payment or funding from any organization.

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Mitigating Potential Bias

- No Mitigation performed

Preparation and Presentation solely my own without support or input from Viewpoint Medical Assessments or Centric Health
Medical Causation

Ways to Think about Causation

• Bradford Hill Criteria
• Genovese
• AMA Impairment Guides
Austin Bradford Hill

- Criteria Defined for Epidemiology in Public Health and Occupational Diseases

- Review of the Original Paper shows a discussion of ways to think about association (not really formal Criteria or “Rules” at all – Bradford Hill simply called them viewpoints)

- The paper was for discussion at the Inaugural Meeting of the Section of Occupational Medicine – Royal Society of Medicine – 1965
Bradford Hill’s Viewpoints

- Strength of association
- Consistency of association
- Specificity of association
- Temporality
- Gradient – or Dose association
- Plausibility
- Coherence
- Experiment
- Analogy
Genovese’s Criteria for MSK Injury

- Temporal Relationship
- Mechanism
- Contiguity
- Consistency
- Specificity
- Coherence
Genovese’s Criteria for MSK Injury

Temporal Relationship
Was the timing of the injury and appearance of symptoms consistent

Mechanism
Is the diagnosis consistent with the mechanism of injury
Genovese’s Criteria for MSK Injury

Contiguity
Is the time course of the symptoms consistent with expectation

Consistency
Are the symptoms consistent over the course of time – between assessments and in other settings
Genovese’s Criteria for MSK Injury

Specificity
Are there alternate explanations for the condition

Coherence
Do all aspects of the case make sense. Is the case consistent and coherent with scientific knowledge of the nature of the injury and the nature of the diagnosis. Is the presentation scientifically plausible based on similar conditions
A causal event took place
The patient experiencing the event has the specified condition
The event could cause the condition
The event caused or materially contributed to the condition (within Medical Probability)
I will use two common musculoskeletal conditions

Both are known to be caused by Trauma.

In fact, both are commonly thought to be

ALWAYS

caused by Trauma
Why are Occupational Musculoskeletal Injuries Important?

In Ontario, MSK work injuries cost $314 million per year between 2003 and 2007 (Ontario Ministry of Labour)

46% of WSIB Lost Time Claims during this period were due to MSK injuries
The MSK Two

Rotator Cuff Tears

Meniscal Tearing of the Knee
The MSK Two

These diagnoses have an “action verb” as part of the diagnosis name.

Tear

The presence of the action word in the diagnoses leads us to presume that the etiology is active and traumatic in nature.
A Tear Isn’t Always A Rip

Research reveals that these conditions are not necessarily traumatic

In fact, these conditions may be most often

NOT

Traumatic
Rotator Cuff

- The rotator cuff is a group of 4 muscles that stabilize and provide much of the motion of the shoulder.
- The shoulder joint is extremely loose and stability is provided by the rotator cuff and some ligaments.
- Supraspinatus, Infraspinatus, Subscapularis and Teres Minor all originate on the scapular blade
- All muscles have tendons that insert onto the head of the humerus. Tears occur in the tendons.
Incidence of Rotator Cuff Tears

- Increases with age
- Rare under age 40*
- Almost always occur in tendons with degeneration
- * In younger people high loads across the supraspinatus often results in the tendon pulling bone off the humeral head or tearing the muscle – no cuff tear in the tendon
Avulsion Fracture – Young Cuff
Age and Rotator Cuff Tears

- Age 40-50  15% with a rotator cuff tear
- Age 50-60  30% with a rotator cuff tear - 80% partial thickness
- Ages 60 to 70 - 50% with a rotator cuff tear – 50% partial thickness and 50% full thickness
- Complete Tears and Massive Tears increase over the age of 60
- No differences between gender or dominant shoulder

NO TRAUMA NECESSARY!
Age and Rotator Cuff Tears

![Bar chart showing the age distribution of specimens with different types of rotator cuff tears.](chart.png)
Age and Rotator Cuff Tears

Figure 4-14.
Non-Traumatic Factors - Age

- The ratio of young Collagen (I) to old Collagen (III) decreases with age.

- Fibroblast to Fibroclast ratio reduces - destructive processes predominate

- Blood flow to the articular side of the supraspinatus is poor – site of greatest degeneration – over time this area degenerates first
Kane et. al. (2006) reviewed shoulders of cadavers *

36 cadavers (72 shoulders) all accident victims.

Shoulders from Smokers were twice as likely to have rotator cuff tears than shoulders than Non-Smokers. Smoking confirmed by pathological lung exam.

Higher emphysema scores correlated with higher degree rotator cuff tears.

High degree of degeneration (Grade 3 to 4 – fatty infiltration) twice as likely in smokers than non-smokers.

* Initial survey study only with small sample size – insufficient for statistical significance
Baumgarten et al. (2010) reviewed 586 consecutive patients presenting for shoulder ultrasound. Patients had no trauma and no prior shoulder surgery.

- Increased rate of rotator cuff tears with duration of smoking, pack years, and current smoking intake.

- Age was still a risk in non-smokers, but rotator cuff tears were significantly more prevalent in smokers

- Cuff tears were front end loaded to younger ages in smokers.

- Results were highly significant
Carbone et al. (2013) reviewed patients with rotator cuff tears undergoing surgery.

Larger tear sizes were related to smoking amount and duration.
In patients undergoing rotator cuff repair, the presence of hypertension was associated with:

- OR of 2 for a large tear
- OR of 4 for a massive rotator cuff tear

Compared to normotensive patients with rotator cuff tears.

Even with antihypertensive treatment, duration of hypertension increased the risk of large tears.
Some indication of higher rotator cuff tear incidence with increased blood sugar

In diabetics excessive glycation of tendons results in thickened fragile tendons. This process is well known in the plantar fascia and Achilles tendon.

Some indication of higher rate of rotator cuff tear degeneration in persons with obesity. Mechanisms unclear yet, but correlated with diabetes, blood vessel pathology, C-reactive protein and possibly specific obesity related inflammatory molecules.
Tendon pathology in persons with diabetes and or obesity may reflect deficient healing of minor tendon injuries.

Adipokines may attract macrophages to fatty tissue, leading to reduced macrophage levels in areas of musculoskeletal injury.

Body mass index greater than 35 is associated with an OR of greater than 3 for developing rotator cuff disease requiring surgery.
Body Mass Index Greater than 35 is also associated with an increased need for knee and hip joint replacement (Odds Ratios for knee and hip pathology is higher than shoulders though)

The observation of high levels of degeneration in shoulders of obese patients suggests that mechanical loading of the knee in obese persons is not the only factor leading to advanced knee degeneration requiring joint replacement.

(Wendelboe et. al. 2003 & 2004)

Obesity in and of itself appears to have an intrinsic risk of causing joint degeneration separate from excessive mechanical loading.
Meniscus of the Knee

- A crescent shaped structure made of fibrous cartilage.

- Two menisci – medial and lateral

- The menisci originate on the capsule of the joint and protrude into the joint. Functions by defining the outer edge of the knee joint on top of the smooth plateau of the tibia.

- The two condyles of the femur sit in the cups defined by the menisci
Meniscus of the Knee
The vast majority of acute meniscal tears occur on the medial side. The capsule is tighter on the medial side. When the knee is twisted with the foot planted, the capsule on the medial side reaches its rotational limit at which point the meniscus tears on its thin inner edge – almost always in the posterior portion of the medial meniscus.
Acute injury to the lateral meniscus is rare.

The lateral capsule is looser and is divided into two portions by the popliteal tendon.

The incidence of false positive tears on MRI is higher on the lateral side. In other words because the event is rare, the test is correspondingly poor.

Horizontal tears, complex tears, flap tears and tears superimposed on degeneration are associated with aging.

Bucket handle tears, longitudinal tears and radial tears are more evenly spread across age groups and are usually traumatic.
Mensical Injury

- Treatment for acute tears is effective – but not benign. Function improves - but

- If 15-30% of meniscus is removed, forces between the tibia and femur increase up to 350%

- Decades later, increased osteoarthritic changes occur, but most patients rate the outcome to still be good to excellent ten years out.
Meniscal Tearing and Age

Englund et. al. 2008 NEMJ

991 randomly chosen people age > 50 in Framingham Mass. MRI of every right knee plus Questionnaire regarding knee symptoms

Women 50-59  19% had a meniscal tear  -  Lowest Prevalence
Men 70-90  56% had a meniscal tear  -  Highest Prevalence

When people with previous knee surgery were excluded, the incidence was the same.

The incidence of meniscal tears was the same whether or not pain was present.
Englund et al. Cont’d

• Incidence of meniscal tear increased with age in men and women. Women always lower incidence.

• Mensical disintegration similar in men of all ages.

• After age 65, meniscal disintegration increased in women and became greater than men.

• Knee pain was related to osteoarthritis.

• Meniscal degeneration was higher with osteoarthritis
Mensical Changes with Age

![Graphs showing the prevalence of meniscal tear and destruction with age for men and women.](Image)
Smoking, Your Parents & Your Knee

- Ding (2007) assessed the effects of heredity and smoking on knee degeneration.
- Subjects were chosen on the basis of 1 parent with knee osteoarthritis or not (controls)
- Current or recent smokers with OA parents had a significant increase in progression of degeneration of knee cartilage over 2.3 years
- Heavy smokers did worse
- Controls (parents without OA) who smoked were minimally worse than non-smoking controls
Conclusions

Despite the bulk of this presentation being devoted to non-traumatic pathology of the knee and shoulder

Rotator cuff tears and meniscal tears are still common consequences of trauma

But NOT always!
Conclusions

The presence of pre-existing degeneration may render a structure more prone to an acute tear or herniation

BUT

We still need to see;

- a torque of the knee
- a loading of the rotator cuff
Meniscal tears are common in young athletes with pristine knees.

Meniscal tears arise due to degenerative processes AND to trauma in older age groups.

Rotator cuff tears of a traumatic nature are most likely to occur superimposed on some degree of degeneration.

Conclusions
If there is no Mechanism that might cause a particular condition – then any pathology found is not likely to be related to that incident.

Seemingly traumatic conditions may actually be more common as degenerative conditions. The Specificity Criterion must be addressed.
TEMPORALITY is a concern.

IF there is advanced fatty muscle atrophy and substantial muscle retraction on MRI – it’s not a recent rotator cuff tear, BUT additional tearing is more likely with the right MECHANISM.

If there is complex tearing of the meniscus – most of it is not a recent tear BUT complex tears can extend acutely and become unstable if the MECHANISM makes sense.
CONCLUSIONS – Back to the Beginning

- CONTINUITY  - Lack of ongoing symptoms may indicate that the imaged structure is not actually the problem.

- CONSISTENCY  – If the signs and symptoms are not consistent with the pathology, then the imaged pathology is not the root of the clinical problem.
Conclusions

Don’t start with the MRI

Start with the MECHANISM
Conclusions

If you like your joints

DON’T SMOKE

Smoking affects far more than lungs and heart

There’s more to Obesity than mechanical effects
Degeneration is not Inevitable
References


Oschman, Z. et. al. 2007 Ultrasound study of the asymptomatic shoulder in patients with a confirmed rotator cuff tear in the opposite shoulder. SASJM 19: 23-28


Sun Y. et. al. 2012. Histological Examination of Collagen and Proteoglycan Changes in Osteoarthritic Menisci. The Open Rheumatology Journal 6: 24-32


ADDENDUM

Not Specifically Related to Musculoskeletal Issues, but an excellent discussion of applying causation criteria to consequences of Stroke and Brain Injury.