



Stiff Knee

Definition, pathoanatomy and classification





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Disclosures: Nothing to declare


 ICVS/3B's
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Arthrofibrosis


How to prevent and fight...

?




Arthrofibrosis...

...a "silent" enemy without a recognizable face??!!



Early Diagnosis and STRATEGY

- talk, examine and LISTEN to your patient
 - Early consultation after surgery
- "what to look for"
 - - we must think this problem is REAL
 - - Potential causes
- Tools for diagnosis
 - - some new trends and possibilities



- Expect the unexpected!
 - Surgical error is sometimes the answer




Arthrofibrosis

- Arthrofibrosis represents a **wide spectrum of disease**, ranging from **localized** to **diffuse** involvement of **all compartments** of the knee and of the **extra-articular soft tissues**
- Multifactorial** - **mechanical** and **biologic factors**.
- Major risk factors:**
 - technical errors in intra-articular ligament reconstruction and extraarticular procedures,
 - injury severity, timing of surgery,
 - delayed postoperative physical rehabilitation,
 - heterotopic ossification
 - prolonged immobilization
 - infection,
 - complex regional pain syndrome.
 - genetic differences among patients with arthrofibrosis.

David Magill, MD, et al **Arthrofibrosis of the Knee** *J Am Acad Orthop Surg* 2007;15:682-694
 Shelbourne KD, Patel DV: **Treatment of limited motion after anterior cruciate ligament reconstruction.** *Knee Surg Sports Traumatol Arthrosc* 1999;7:89-92

Trauma severity/Energy

- Motion Loss - **more common with multiligamentous high-energy** injury than with single-ligament low-energy injury
- Concomitant ACL and MCL repair**
 - Noyes et al - 23% incidence of motion loss
- Traumatic knee dislocation incidence of motion loss**
 - Sisto and Warren 30%
 - Shapiro and Freedman 57%

Timing of surgery

...“multiple techniques used for reconstruction, variable definitions of timing and classification, and lack of prospective studies, firm conclusions regarding this **ongoing debate remain elusive.**”

“Key factor remains **understanding the mechanism and severity** of injury as they relate to the **preoperative level of inflammation**”

Sprague Pathoanatomic Classification of Motion Loss

Group	Pathoanatomy
1	Discreet bands or a single sheet of adhesions traversing the suprapatellar pouch
2	Complete obliteration of the suprapatellar pouch and peripatellar gutters with masses of adhesions
3	Multiple bands of adhesions or complete obliteration of the suprapatellar pouch with extracapsular involvement with bands of tissue from proximal patella to anterior femur

Reproduced with permission from Sprague NF III, O'Connor RL, Fox JM: Arthroscopic treatment of postoperative knee fibroarthrosis. *Clin Orthop Relat Res* 1982;166:165-172.

Sprague NF III, O'Connor RL, Fox JM: Arthroscopic treatment of postoperative knee fibroarthrosis. *Clin Orthop Relat Res* 1982;166:165-172.

Classification of Motion Loss of the Knee Based on Deviation From Full Flexion and Extension

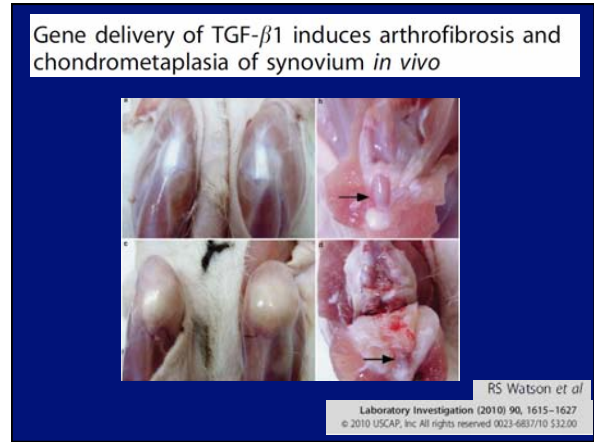
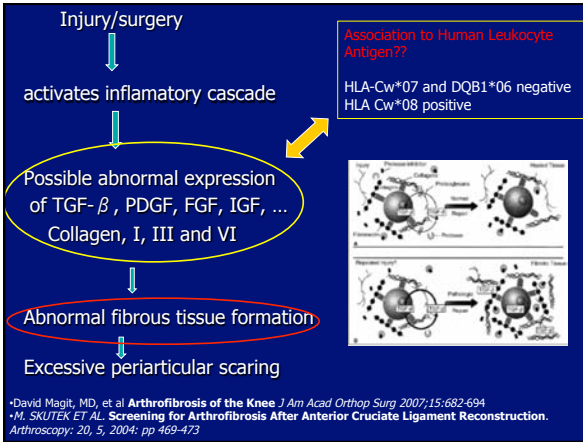
Group	Extension	Flexion	Severity
1	<5°	>110°	Mild
2	5°-10°	90°-110°	Moderate
3	>10°	<90°	Severe

Del Pizzo W, Fox JM, Friedman ML, et al: Operative arthroscopy for the treatment of arthrofibrosis of the knee. *Contemp Orthop* 1985;10:67-72.

Level of Arthrofibrosis According to Shelbourne et al.

	Extension Deficit	Flexion Deficit	Other Criteria
Type I	<10°	No	No
Type II	>10°	No	No
Type III	>10°	>25°	Contract patella
Type IV	>10°	>30°	Patella baja

Shelbourne KD, Patel DV, Martini DJ. Classification and management of arthrofibrosis of the knee after anterior cruciate ligament reconstruction. *Am J Sports Med* 1996;24:857-862.



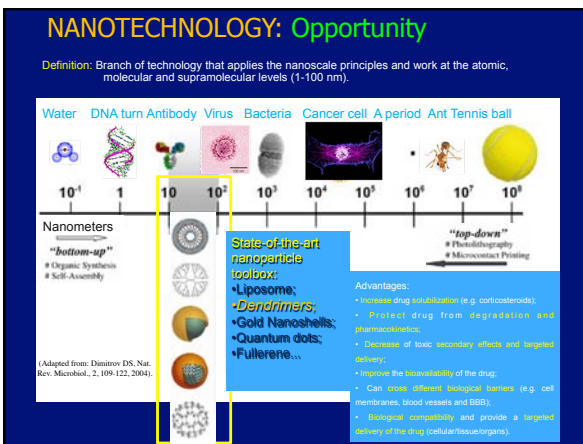
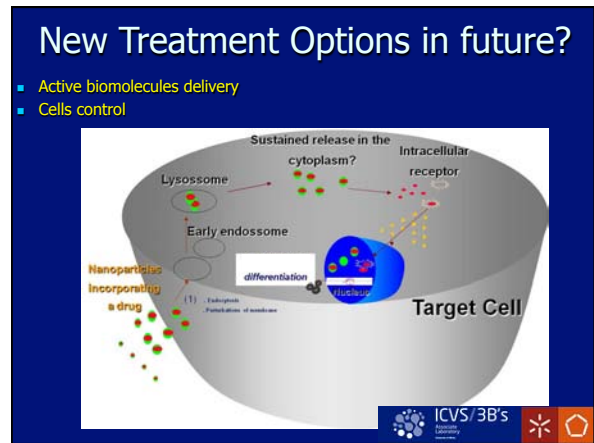
Reactive oxygen and nitrogen species induce protein and DNA modifications driving arthrofibrosis following total knee arthroplasty

Background: Arthrofibrosis, occurring in 3%-4% of patients following total knee arthroplasty (TKA), is a challenging condition for which there is no defined cause. The hypothesis for this study was that dysregulated production of reactive oxygen species (ROS) and nitrogen species (RNS) mediates matrix protein and DNA modifications, which result in excessive fibroblastic proliferation.

Results: We found increased numbers of macrophages and lymphocytes, along with elevated amounts of myeloperoxidase (MPO) in arthrofibrotic tissues when compared to control tissues. MPO expression, an enzyme that generates ROS/RNS, is usually limited to neutrophils and some macrophages, but was found by immunohistochemistry to be expressed in both macrophages and fibroblasts in arthrofibrotic tissue. As direct measurement of ROS/RNS is not feasible, products including DNA hydroxylation (8-OHdG), and protein nitrosylation (nitrotyrosine) were measured by immunohistochemistry. Quantification of the staining showed that 8-OHdG was significantly increased in arthrofibrotic tissue. There was also a direct correlation between the intensity of inflammation and ROS/RNS to the amount of heterotopic ossification (HO). In order to investigate the aberrant expression of MPO, a real-time oxidative stress polymerase chain reaction array was performed on fibroblasts isolated from arthrofibrotic and control tissues. The results of this array confirmed the upregulation of MPO expression in arthrofibrotic fibroblasts and highlighted the downregulated expression of the antioxidants, superoxide dismutase 1 and microsomal glutathione S-transferase 3, as well as the significant increase in thioredoxin reductase, a known promoter of cell proliferation, and poly(ADP-ribose) kinase 3-phosphatase, a key enzyme in the base excision repair pathway for oxidative DNA damage.

Conclusion: Based on our current findings, we suggest that ROS/RNS initiate and sustain the arthrofibrotic response driving aggressive fibroblast proliferation and subsequent HO.

Fibrogenesis & Tissue Repair 2009, 2:5



Clin Orthop Rel Res (2010) 468:1199–1216
DOI 10.1007/s11999-010-1219-7

CLINICAL RESEARCH

How to Treat the Stiff Total Knee Arthroplasty?
A Systematic Review

Sean E. Fitzsimmons MD, Edward A. Vanquec BS,
Michael J. Brennum MD, FACS

Arthrofibrosis after TKA - Influence factors on the absolute flexion and gain in flexion after manipulation under anaesthesia

Spach et al. *BMC Musculoskeletal Disorders* 2011, 12:184
<http://www.biomedcentral.com/1471-2474/12/184>

BMC Musculoskeletal Disorders

The Journal of Arthroplasty Vol. 27 No. 2 2012

Total Knee Arthroplasty in Patients With Stiff Knees

Chi-Hsiang Hsu, MD, Po-Chun Lin, MD, Wun-Schen Chen, MD,
and Jun-Wen Wang, MD

Arthrofibrosis – after Ligament surgery

Prevention of motion loss remains essential to successful outcome.

In the patient who experiences motion loss despite preventive measures, treatment options include **static or dynamic bracing, manipulation** under anesthesia and **arthroscopic or open débridement**.

In recalcitrant cases, **arthrodesis** in the older patient or total knee arthroplasty may be required.

•David Magit, MD, et al **Arthrofibrosis of the Knee** *J Am Acad Orthop Surg* 2007;15:682-694

“as little as 5° to 10° loss of extension”

↓
abnormal gait pattern

↓
quadriceps weakness

↓
Anterior knee pain

Complications and Treatment During Rehabilitation After Anterior Cruciate Ligament Reconstruction
Nicholas D. Potter, Oper Tech Sports Med 2006 14:50-58

The better surgeons repair...
better is the outcome!

Early stage (80's):

as many as **35%** of patients with acute ACL repair developed loss of knee motion

Strum GM, Friedman MJ, Fox JM, et al: Acute anterior cruciate ligament reconstruction: Analysis of complications. *Clin Orthop Relat Res* 1990; 253:184-189.

Advances in surgical technique and accelerated rehabilitation protocols:

incidence has markedly decreased, to as low as **0% to 4%**

David Magit, MD, et al **Arthrofibrosis of the Knee** *J Am Acad Orthop Surg* 2007;15:682-694
Al SKUTTEK ET AL. Screening for Arthrofibrosis After Anterior Cruciate Ligament Reconstruction. *Arthroscopy*; 20, 5, 2004; pp 469-473

Surgical technical errors

Nonanatomic graft placement

Inadequate graft fixation

notchplasty

Incorrect graft tension



- **12% early incidence of knee stiffness** after primary ACL reconstruction
- Strongest predictors:
 - Previous surgery
 - poor compliance with rehab
- Conservative treatment results
 - Rate of stiffness fell to 5% at 12 months

G.A.J. Robertson et al. / *The Knee* 16 (2009) 245–247

Localized presentation - CYCLOPS

- Proliferative scar nodule in femoral notch
- Painful mechanical block to knee extension
- Crepitus and physical sensation of grinding with knee extension
- Dx clinical, MRI, arthroscopy



B. SONNERY-COTTET ET AL. Clinical and Operative Characteristics of Cyclops Syndrome After Double-Bundle Anterior Cruciate Ligament Reconstruction *Arthroscopy* 2010 ; 26,11, 1483-1488

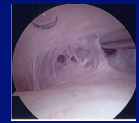
Localized presentation - INS

Intercondylar notch scarring



Bone notch impingement – Often an illusion – graft malposition!

Infrapatellar contracture syndrome (IPCS)



- Pathologic fibrous hyperplasia of the anterior knee following surgery or injury to the knee.
- IPCS is a subcategory of severe arthrofibrosis with extension loss, flexion loss, and patellar entrapment. Hypertrophic scar tissue invades the infrapatellar recess and lowers the patella, resulting in patella infera.
- Trauma to the knee produces bleeding, which initiates the clotting cascade. Inflammatory cells, fibroblasts, and growth factors, including the disordered regulation of collagen 6, contribute to arthrofibrosis synthesis.

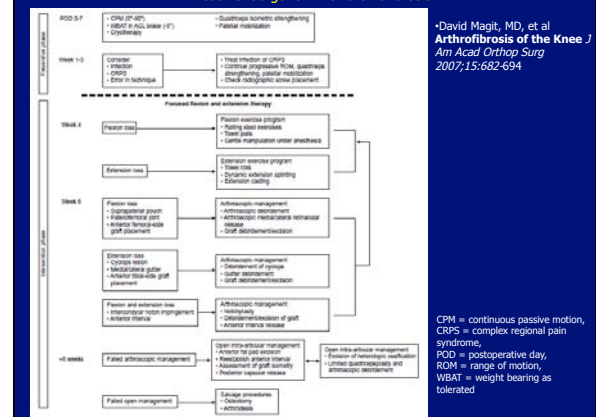
Paulos LE, Wnorowski DC, Greenwald AE. Infrapatellar contracture syndrome. Diagnosis, treatment, and long-term follow-up. *Am J Sports Med.* 1994;22(4):440-449.
Shelbourne KD, Johnson GE. Outpatient surgical management of arthrofibrosis after anterior cruciate ligament surgery. *Am J Sports Med.* 1994;22(2):192-197.

Infrapatellar contracture syndrome (IPCS)



- Phase I – normal phase of healing 2-8 weeks after surgery
Treatment – Rehab protocol **early full extension (hyperextension when applies)**
- Phase II (active) – diminished patellar mobility; patellar tendon rigidity; quadriceps atrophy
- Phase III – Patellofemoral arthritis
Poor prognosis

Treatment algorithm for arthrofibrosis



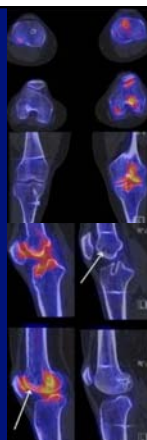
-David Magit, MD, et al
Arthrofibrosis of the Knee J
Am Acad Orthop Surg
2007;15:682-694

Foreign body reactions 99mTc-HDP-SPECT/CT

Painful knee joint after ACL reconstruction using biodegradable interference screws- SPECT/CT a valuable diagnostic tool? A case report

Michael T Hirschmann¹, Tom Adew¹, Helmut Rauch², Rolf W Högler³, Nikolaus F Friederich⁴, Markus P Arnold⁵

- metabolic information (tracer uptake in SPECT/CT)
- precise anatomical detail available with high spatial resolution CT
- foreign body reaction, confirmed by histology



Hirschmann et al. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology* 2010, 2:24
<http://www.smartjournal.com/content/2/1/24>

Complex Regional Pain Syndrome

Stages of Complex Regional Pain Syndrome

Stage	Usual Time Course (mo)	Clinical Features	Radiographic Findings
Acute	0 to 3	Warm, red, edematous extremity; aching, burning pain; intolerance to cold; altered sweat pattern; joint stiffness without any significant effusion; hyperesthetic skin; no fixed joint contractures	Normal plain radiographs; may have abnormal uptake of imaging agent on bone scan
Dystrophic	3 to 6	Cool, cyanotic, edematous extremity; shiny, hyperesthetic skin; fixed contractures; fibrotic changes occur in the synovium	Subchondral osteopenia; patellar and medial femoral condyle osteopenia on sunrise view; may have abnormal uptake of imaging agent on bone scan
Atrophic	6 to 12	Loss of hair, nails, skin folds; fixed contractures; muscle wasting	Bone demineralization

Christopher J. Hogan, MD, and Shepard R. Hurwitz, MD

Treatment of Complex Regional Pain Syndrome of the Lower Extremity
Journal of the American Academy of Orthopaedic Surgeons
Vol 10, No 4, July/August 2002

Take Home Message

- Multifactorial combination of Biologic and Mechanic factors...
Enemy with many faces
- Surgical technique and less aggression decrease the risk
- Early rehabilitation
- Patient related risk factors (HLA, protein expression; biomarkers) might provide future perspectives in prognosis and treatment
- Early diagnosis... Have a strategy!!