

# From Discovery to Market : CAN Case-Studies with BST-CarGel and Arthro-BST

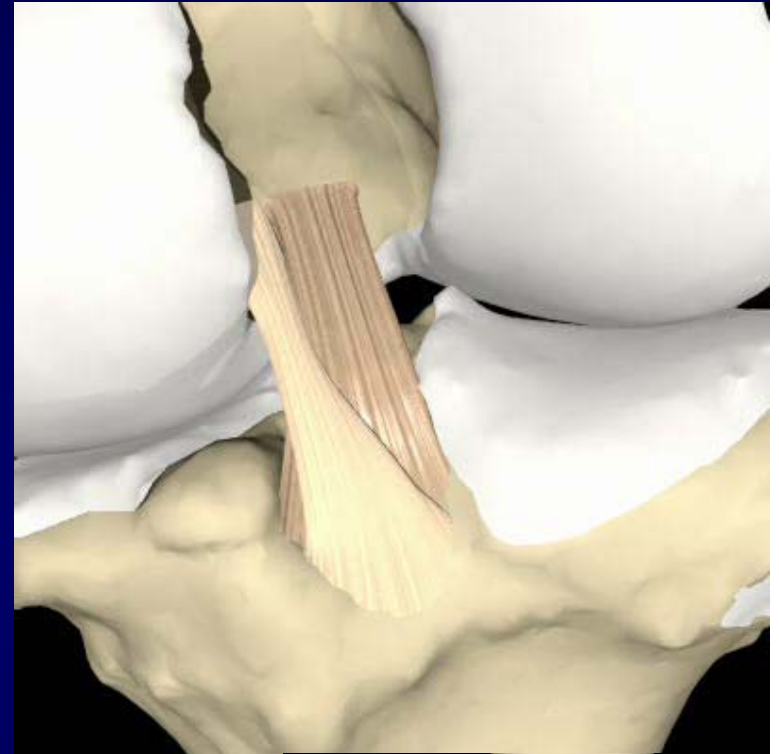
Michael D. Buschmann



Canada Chair in Cartilage Tissue Engineering  
NSERC/BioSyntech Chair in Hybrid Biomaterials  
Institute Biomedical Engineering  
Department Chemical Engineering  
Ecole Polytechnique, Montreal

# Articular Cartilage

- assures nearly frictionless interfaces and lubrication
- transmits and distributes forces to bone



Primal, Interactive knee (Surgery Edition) v. 2.0



# Arthro-BST™



# Spherical Indenter Detects Streaming Potentials



Streaming Potentials in Cartilage

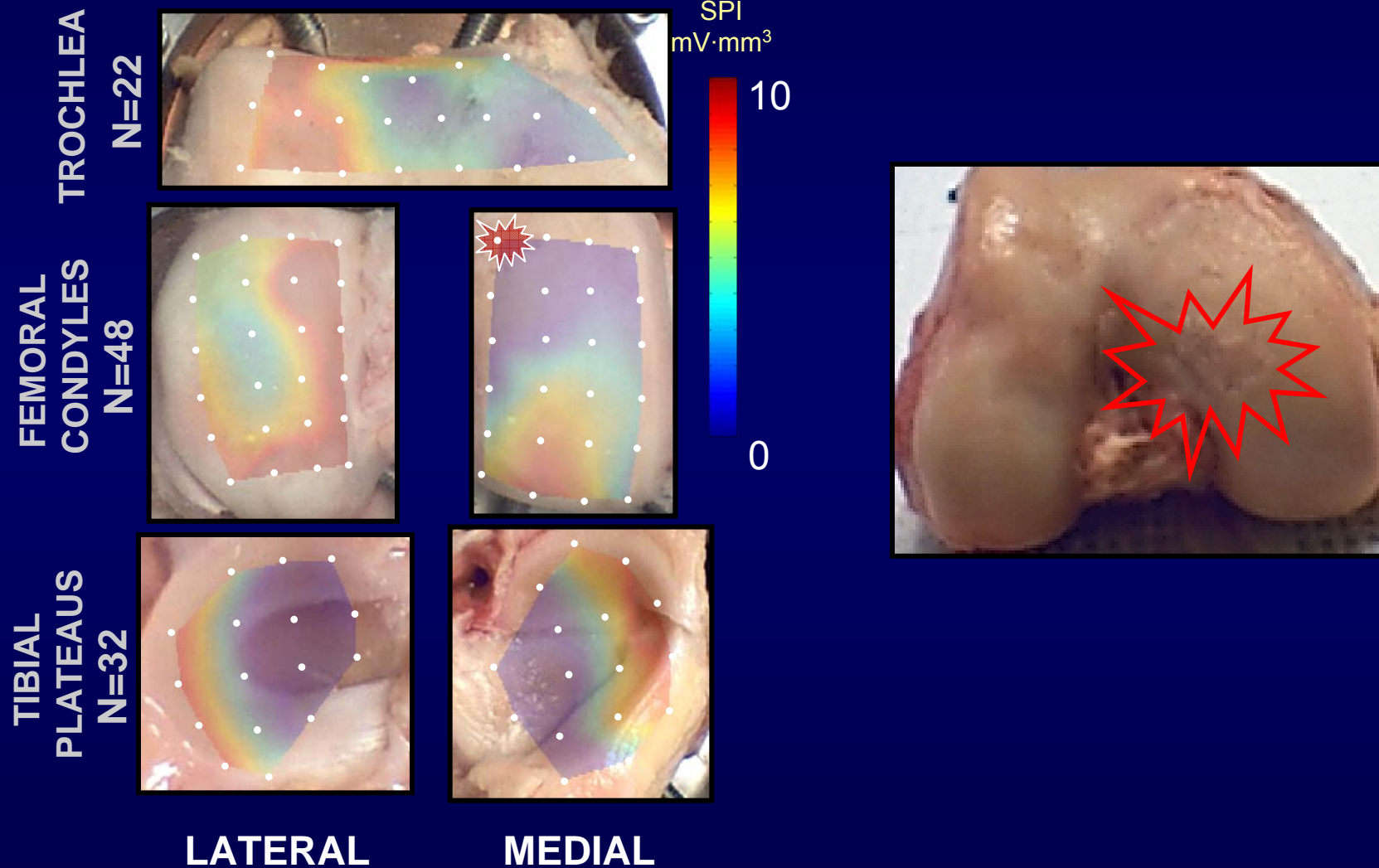
# Arthro-BST™ Software

The screenshot displays the Arthro-BST Software interface. The window title is "ARTHRO-BST Software". The menu bar includes "Menu" and "Help". The main title "ARTHRO-BST™ Software" is prominently displayed. Below the title, the version number "4.6" is shown in a large font, followed by the text "Ready for Measurement".

A graph titled "Electrical Potentials vs Time" is visible, with a y-axis ranging from -70.00 to 10.00. The graph shows a flat line at 0.00. Below the graph, there is a button labeled "PRESS HERE" with the instruction "after compression". At the bottom of the window, a status bar indicates "Arthro-BST System is in operation" with a green indicator light.

On the right side of the interface, there are anatomical diagrams for a "Left Knee". The diagrams are labeled "M" (Medial) and "L" (Lateral). The top diagrams show the medial and lateral views of the knee joint with numbered electrode positions (1, 4, 7, 2, 5, 8, 3, 6, 9). A separate diagram shows a circular electrode array with positions 7, 4, 1, 8, 5, 2, 9, 6, 3. Below these are two diagrams of a knee joint with numbered electrode positions (1, 1).

# SPI Maps of Human Cartilage with the Arthro-BST™



# Summary of Cartilage Assessment with Arthro-BST

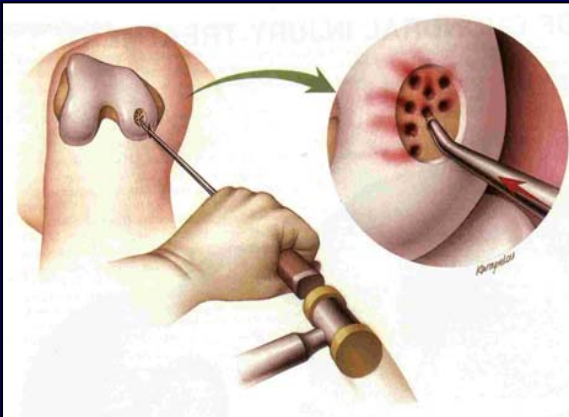
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Streaming potential maps reflect cartilage mechanical function loading patterns and degeneration processes

The instrument is available now for nonclinical use and for clinical use in 2008

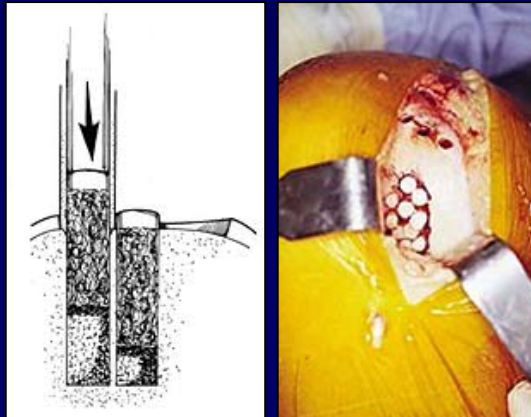
# Cartilage Lesions: Current Treatments

## Microfracture



- Filling by a scar-like fibrocartilage tissue

## Mosaicplasty



- Donor site morbidity
- Efficacy?
- Non-integration of the cylinders in the native cartilage

## Autologous Chondrocyte Implantation



- Expensive, Lengthy
- 2 surgeries
- Efficacy unproven

Pridie KH 1959 *J. Bone and Joint Surgery* 41B: 618-619

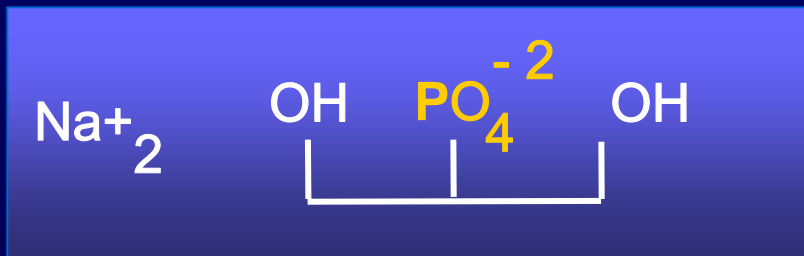
Knutsen et al., 2004 *J. Bone and Joint Surgery*, 86: 455-464

# Cytocompatible Chitosan/GP Solution

Chitosan (200kDa, 80% DDA) - soluble at pH < 6



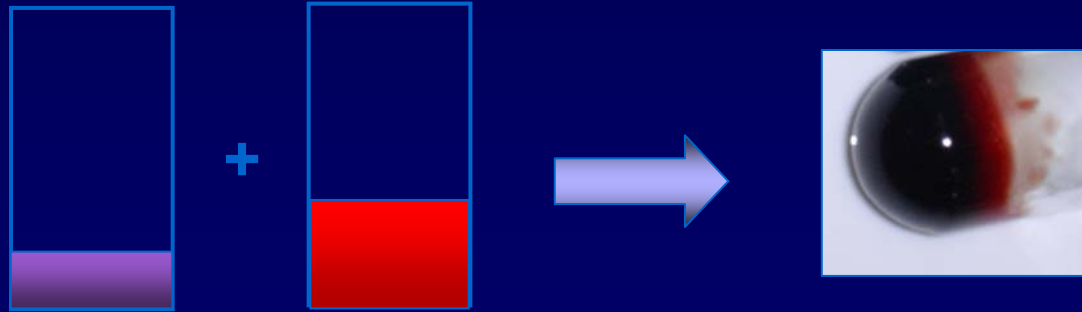
$\beta$ -glycerol phosphate pH 9



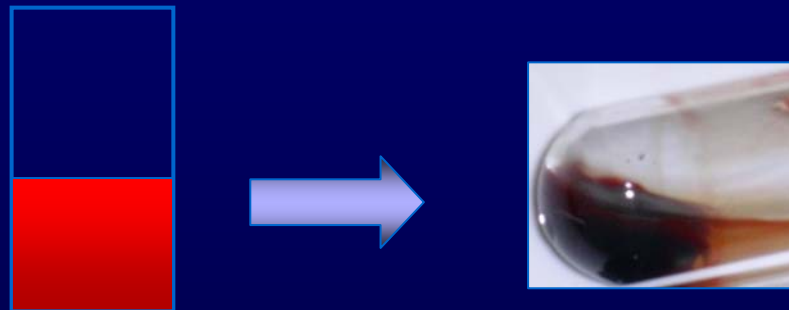
**BST-CarGel®**

1.6% chitosan  
2%  $\beta$ -GP  
pH 6.8

# Chitosan-GP clots vs Blood clots



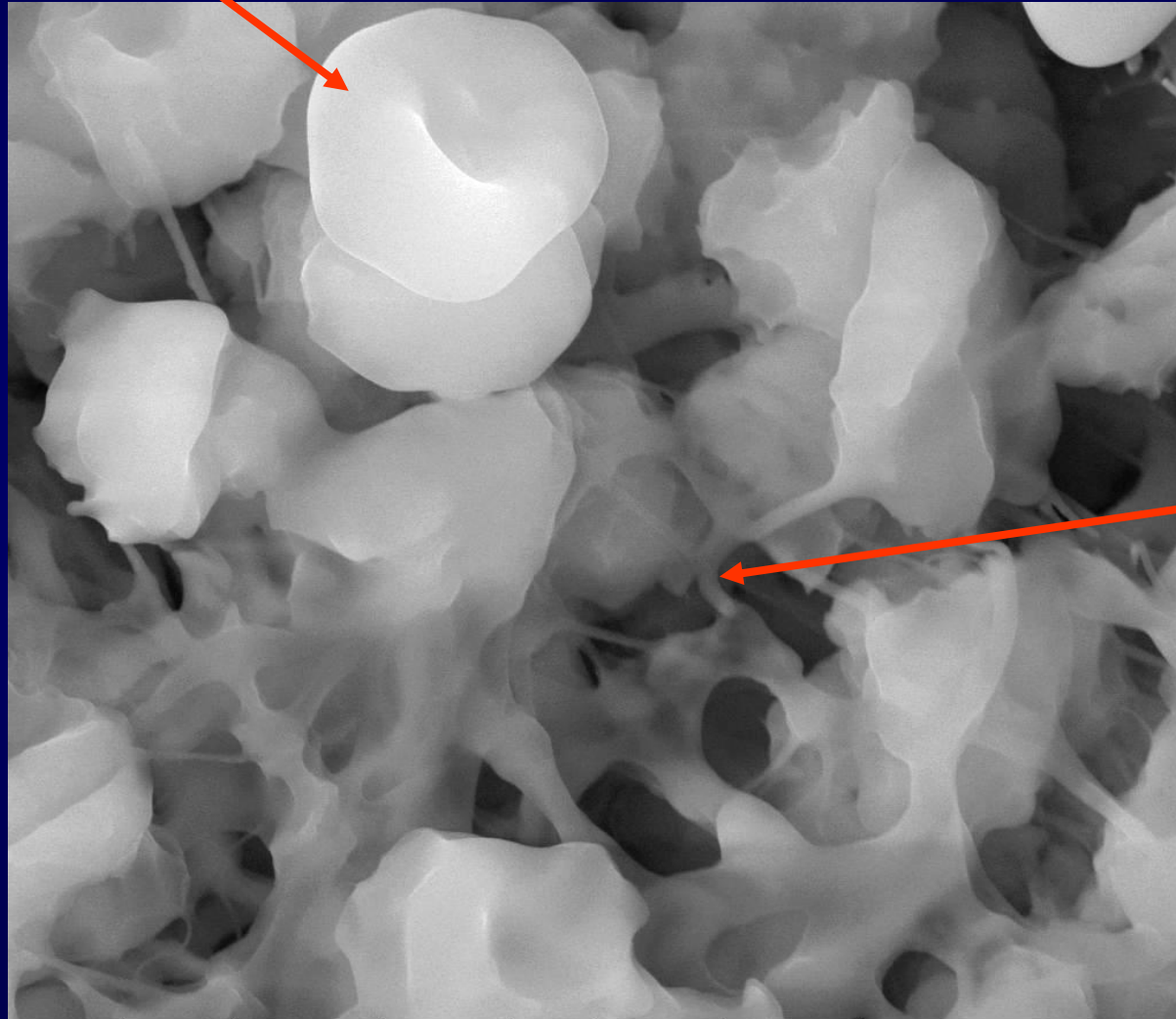
Chitosan-GP + Blood      Chitosan-GP Clot



Blood Clot

# Chitosan-GP clot (unfixed in ESEM)

Erythrocyte

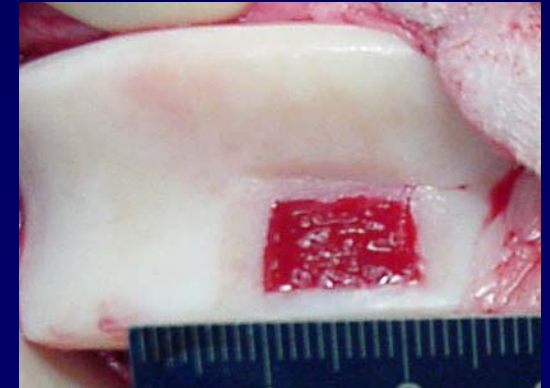


Chitosan  
Fibre

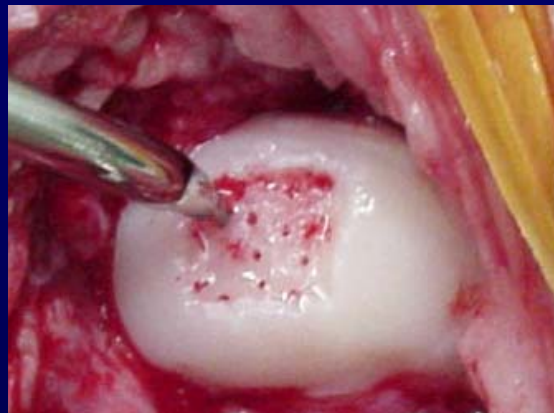
HV	Mag	VacMode	WD	Spot	Pressure	Temp	5 μm
20.0 kV	12000x	ESEM	8.58 mm	3.0	320.0 Pa	281.1 °C	

# SHEEP CARTILAGE REPAIR MODEL

Lateral Trochlea



Medial Femoral Condyle

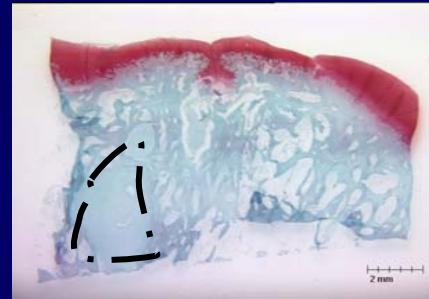
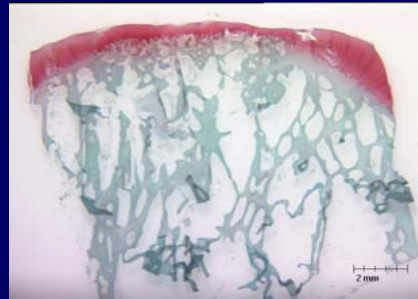
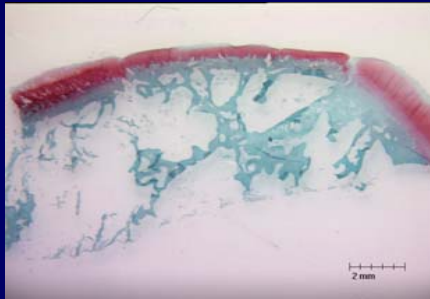


Untreated  
(MFX)

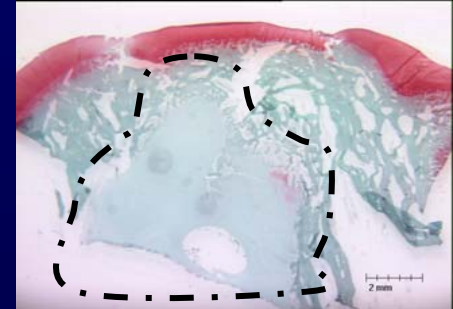
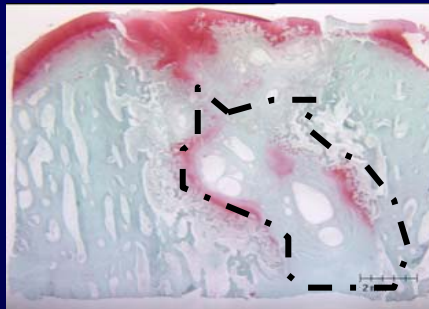
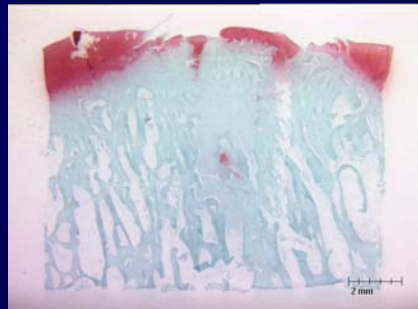
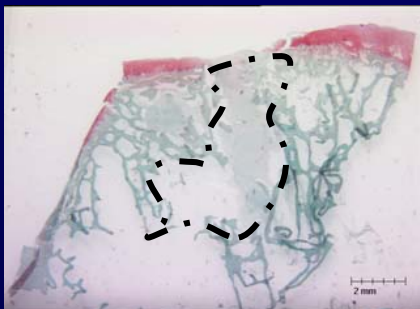
Treated  
(BST-CarGel)

# Condyle Repair at 6 Months 4 Best Cases

## Chitosan-GP/Blood



## Untreated



# Summary of Cartilage Repair

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Chitosan/Blood Improves Quantity and Quality of Cartilage Repair

Mechanisms of Action Include :

- cell recruitment
- neovascularisation
- bone remodeling
- chondrogenesis

# Cartilage Repair with BST-CarGel®

1



BST-CarGel®

2



peripheral autologous blood

3



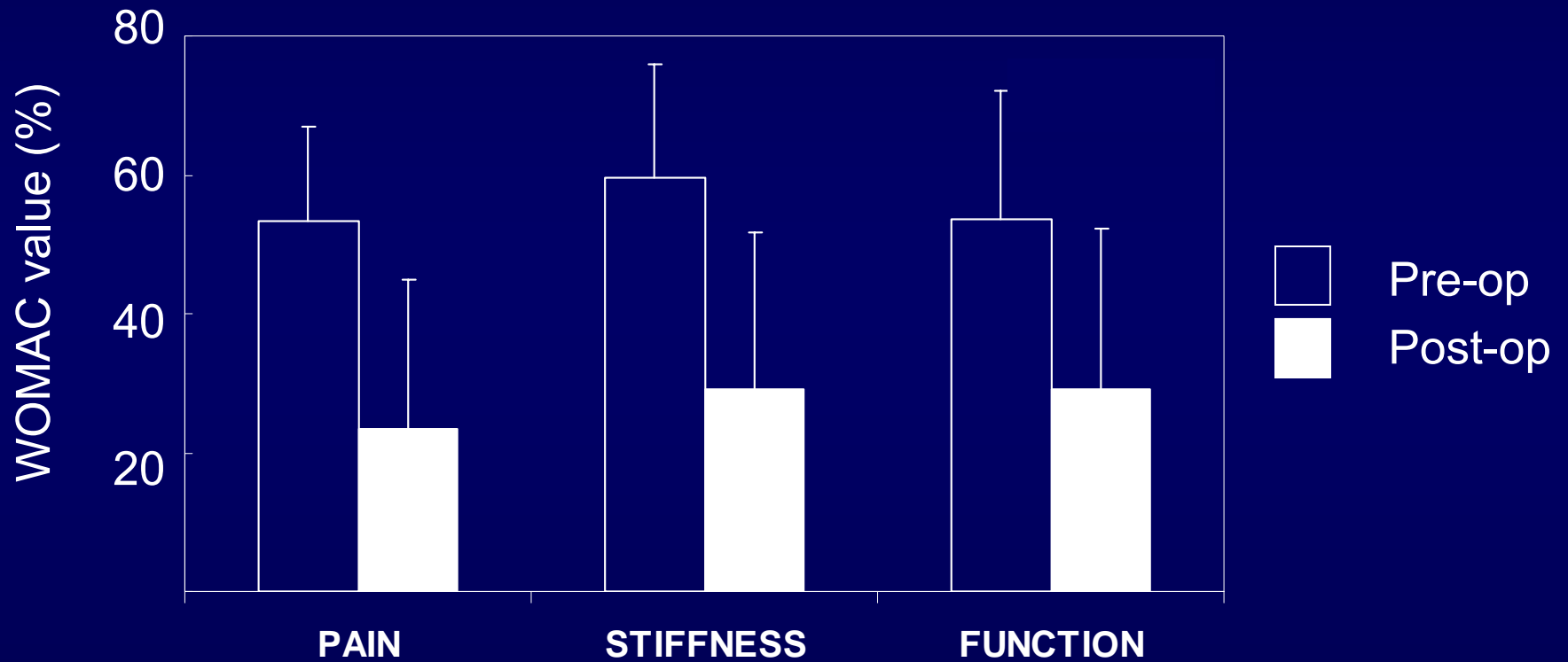
*mix*

4



ready to apply

# Clinical Data at 12 Months vs Pre-Op



reduction in value indicates improvement, Mean  $\pm$  SD (n=9)

Randomized Controlled Multicentre  
Clinical Trial Initiated  
(BioSyntech Inc.)

BST-CarGel™ vs Microfracture

How did these products  
come about ?

# Idea

Company - 1995

Amine Selmani

Arthro-BST - 1996

Dr. Pierre Savard  
Martin Garon

Dr. Robert Guardo  
Anne Légaré  
Dr. Robin Poole  
Eric Quenneville

BST-CarGel - 1997

Dr. Abdellatif Chenite  
Dr. Caroline Hoemann  
Dr. Jun Sun

Dr. Mark Hurtig  
Dr. Marc McKee  
Dr. Matthew Shive  
Dr. Evgeny Rossomacha

# IP

## Arthro-BST

Patent #1  
1997-1999

Patent #2  
1999 - current

## BST-CarGel

Patent #1  
1998 – 2002

Patent #2  
2000 - 2006

# Investment

Private - 1997

Public - 2000

Additional – 2003, 2005, 2006

~40 million to date

Proof of Concept

Publications

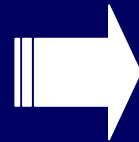
Manufacturing

Clinical

Regulatory

2000 - 2007

Idea  
IP  
Investment



Proof of Concept  
Manufacturing  
Clinical/Regulatory

Belief

Community