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# Tissue Engineered Construct Showed Better Biomechanical Results for Articular Cartilage Restoration in a GMP Pre- Clinical Study

Rafaella Rogatto De Faria, João Paulo Cortez Santanna, Marina J. S. Maizato, Cyro Albuquerque, Daniela Franco Bueno, Arnaldo J. Hernandez, Tiago Lazzaretti Fernandes







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# Disclosures:

Declare no conflicts of interest

Rafaella Rogatto De Faria, Master in progress, São Paulo, São Paulo BRAZIL

Joao Paulo Cortez Santana, MD, MSc, São Paulo, São Paulo BRAZIL

Marina J. S. Maizato, PhD, Sao Paulo, SP BRAZIL

Cyro Albuquerque, Prof., PhD, São Paulo, SP BRAZIL

Daniela Franco Bueno, DDS, PhD, São Paulo, SP BRAZIL

Arnaldo J. Hernandez, MD, PhD, São Paulo, SP BRAZIL

Tiago Lazzaretti Fernandes, MD, PhD, MSc, Post-Doctorate, São Paulo, SP BRAZIL





# INTRODUCTION

- **Cartilage Injuries and Osteoarthritis:**
  - Prevalent and Public Health Problem;
    - 63% of the population (CURL, 1997);
  - Complications:
    - Changes in biomechanics and homeostasis of the joint;
    - Lesions in the adjacent subchondral bone;
    - Loss of mobility;
    - Degeneration;
    - Osteoarthritis of the knee;
  - Gold Standard Cell Therapy:
    - Autologous Chondrocyte Implant (ACI).



# INTRODUCTION

- Tissue Engineering:
  - Mesenchymal Stromal Cells (MSC);
  - Benefits:
    - Ease of harvesting;
    - Cell proliferation and differentiation;
    - No rejection by the patient;
    - Paracrine effect in local cellular machinery.
- Articular Cartilage:
  - Avascular, Non-linear, Viscoelastic;
  - **Biomechanical functions** (i.e. stiffness, load bearing, shock absorption and wear resistance).





# OBJECTIVE

- Compare the restoration of hyaline cartilage with six months follow-up:
  - Defect x Tissue Engineered Construct (TEC) (dental pulp and synovium);
  - Biomechanical evaluation;



# MATERIALS AND METHODS

- Controlled experimental study;
- 14 Brazilian miniature pigs (BR-1);
- Adults aged 8–12 months and weighting 19–22 kg;



(SantAnna et. al. 2022)

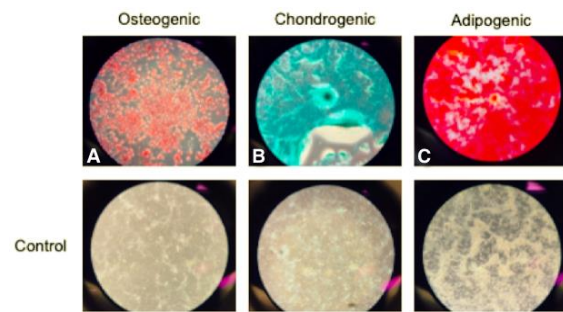


Figure 1. Differentiation of MSCs



Figure 2. 3D TEC structure



Figure 3. Cartilage defect

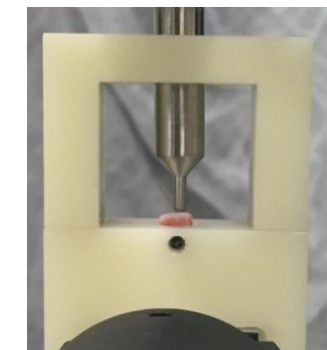


Figure 4. Biomechanical analysis



# MATERIALS AND METHODS

## 4. Mechanical Evaluation

- INSTRON 3365 (Bluehill 3™ software);
- BioPuls™ (temperature controlled);
- Parameters:
  - Speed: 0.5 mm/min;
  - Load: 100 N;
  - Displacement:
    - Indentation: 5% of the cartilage thickness;
    - Maximum Compression: 50% of the total height

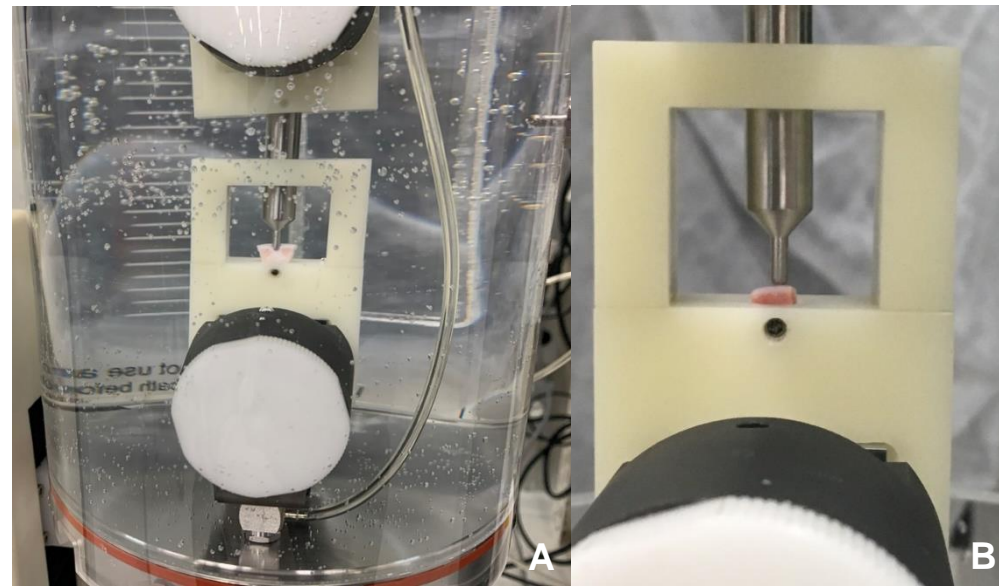


Figure. Biomechanical test set up. (A) Structure immersed in saline solution (0.9% NaCl) at a temperature of 36°C. (B) Sample placed on a support with the cartilage part facing up and positioned on the equipment





# RESULTS AND DISCUSSION

- Indentation Test:
  - Hysteresis phenomenon and Determination of the Young Modulus

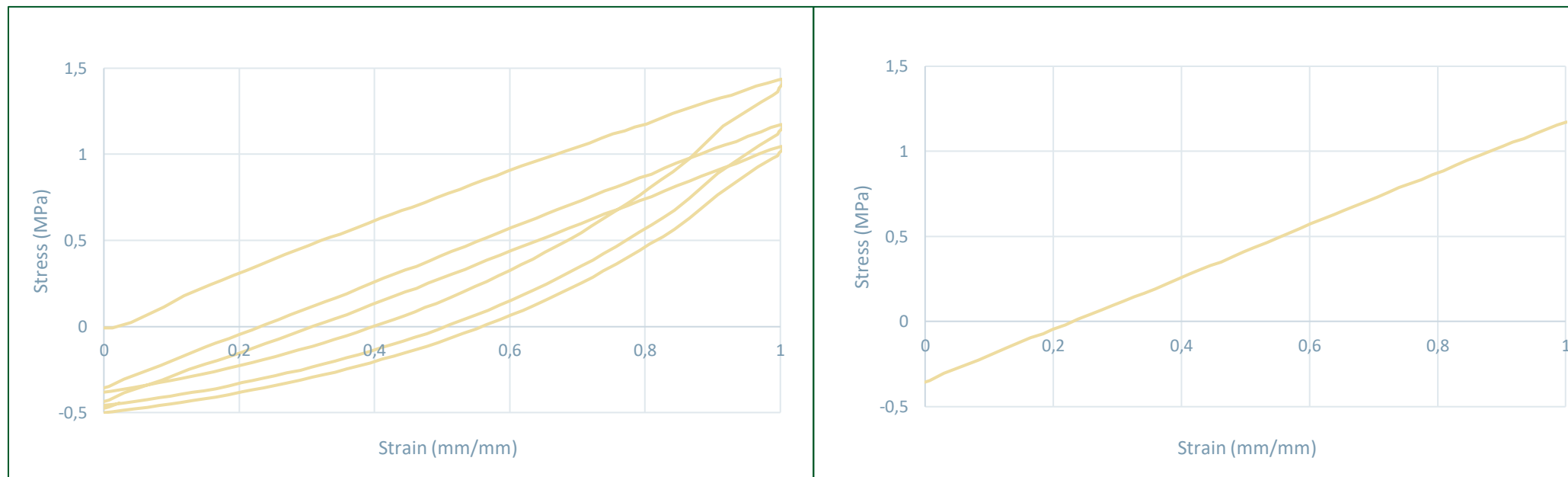


Figure 6. Indentation Test. (A) Stress (MPa) x Strain (mm/mm), showing the three cycles of 5% stress-strain

(B) Stress (MPa) x Strain (mm/mm) showing the ramp of the second cycle of the test



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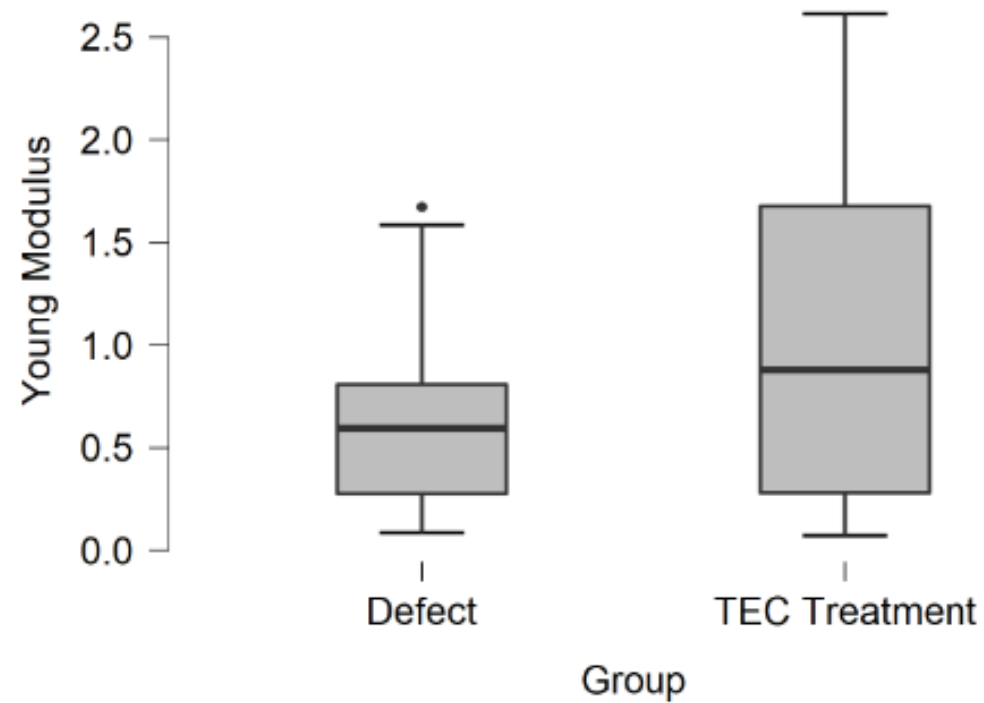
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# RESULTS AND DISCUSSION

- Indentation Test:
  - The average value of Young Modulus was 41% lower on the defect group compared to the treated group.





# RESULTS AND DISCUSSION

- Maximum Compression Test: Non-linearity of the cartilage
- Finite Element Model (ANSYS R 17.2): Force distribution

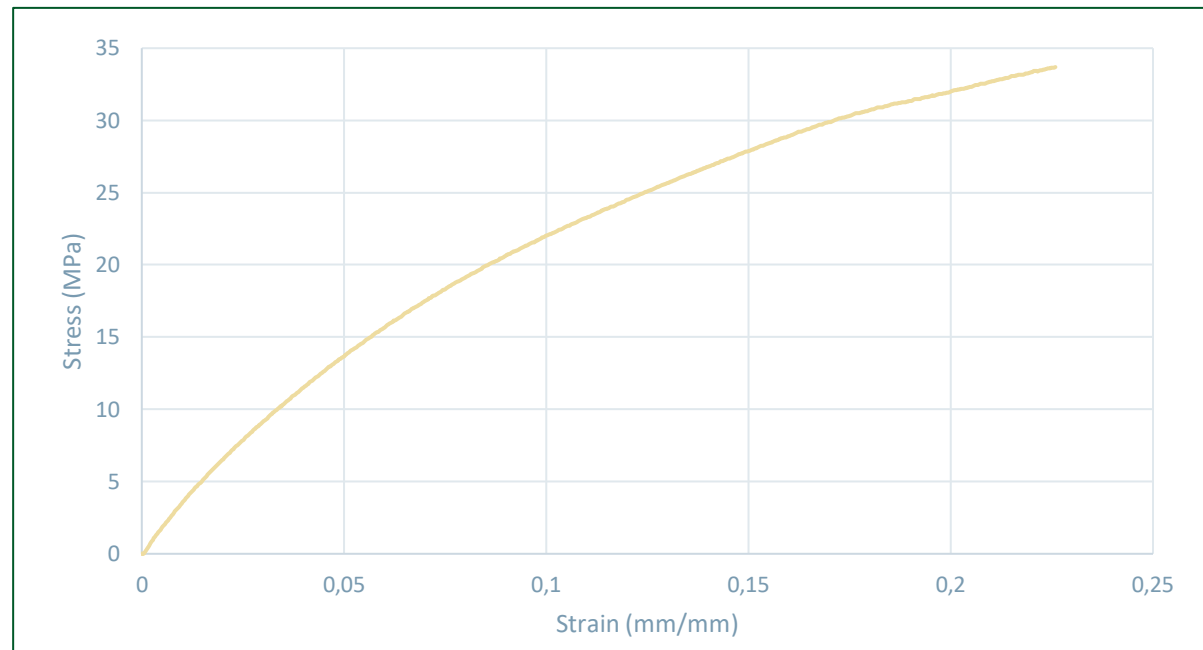


Figure. Maximum Compression Test, Stress (MPa) x Strain (%)

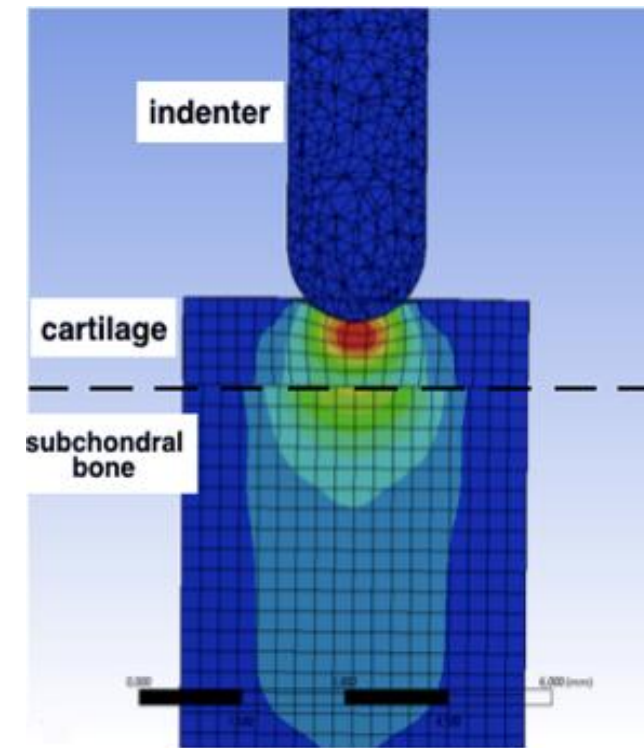


Figure. Finite Element analysis image indicating the cartilage above the dashed line and the subchondral bone below





# CONCLUSION

- The proposed method allowed feasible and capable evaluation of the physical properties of the articular cartilage restoration. A higher YM value in the treated group might indicate superior repair. The FE model allowed for better visualization of the structure when undergoing compression.





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