

# Effect of the liquid phase and polymer contents on the setting and mechanical behaviour of a calcium phosphate bone cement

## NanoMatLab/Biomat Meeting

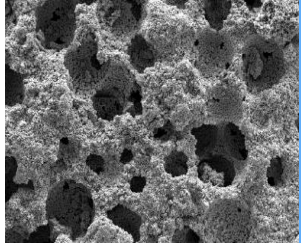
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Doctor Nuno Ribeiro

### Acknowledgements:

Professor Rogério Colaço  
Andreia Pimenta  
Lígia Figueiredo  
BIOMAT Team

Marta Reis  
MSc Student



# A small introduction...



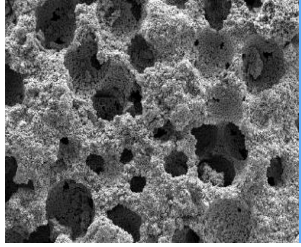
- Marta Reis



- Student at the MSc in Biotechnology



- Currently doing the project before the MSc thesis



# Bone Anatomy & Physiology

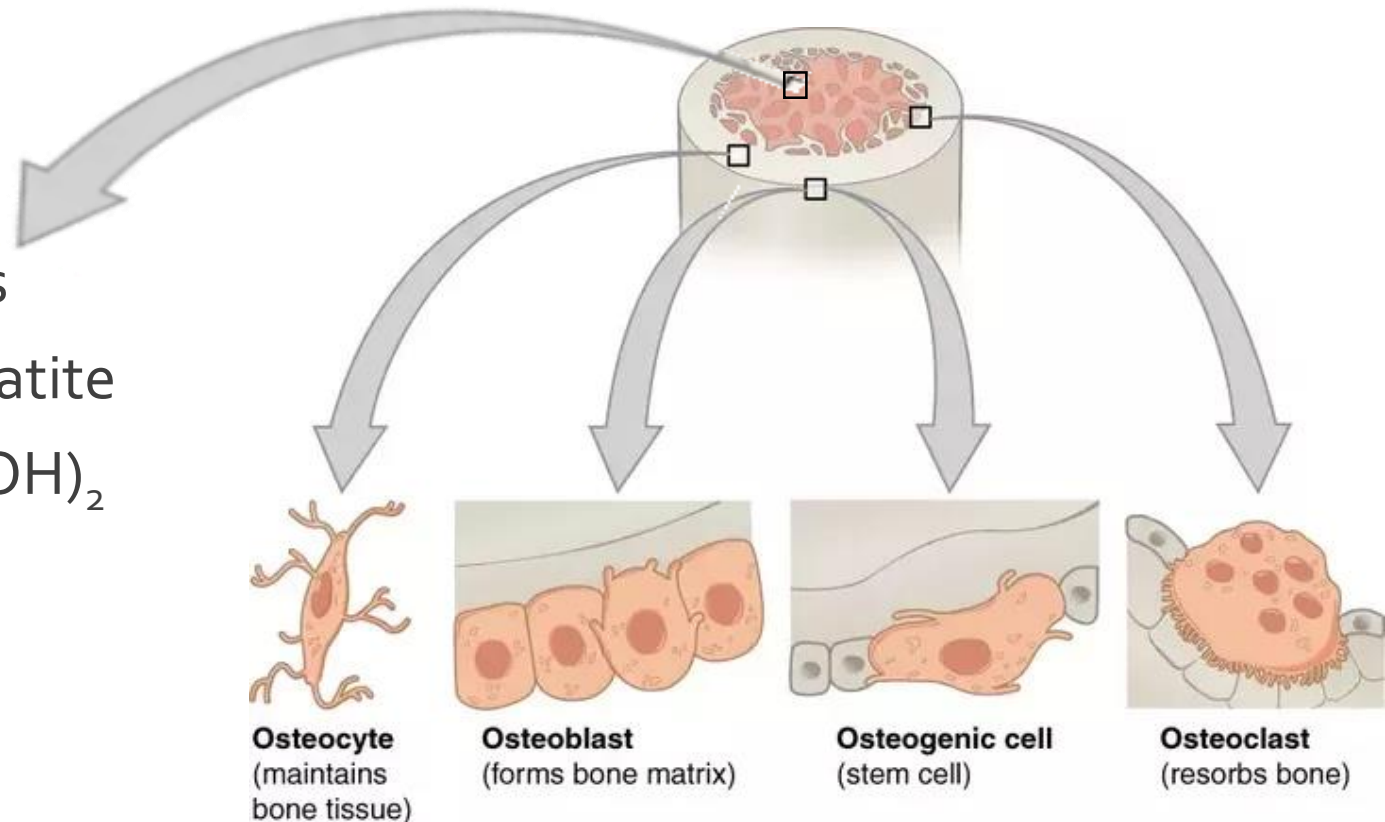
- Composed by:

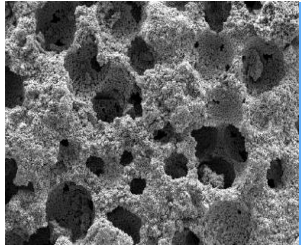
MATRIX

- **35% Organic:** protein fibers
- **65% Inorganic:** hydroxyapatite



BONE CELLS

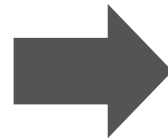




# Bone Injury: CPCs as a solution

- **Causes:** physical injury (trauma), infection, tumour, genetic disorders, metabolic diseases
- **Method:** Bone grafting
  - Autograft or allograft
  - Synthetic Bone Substitutes

## Calcium Phosphate Cements



Biocompatibility

Osteoinduction

- 1) Dissolution of CaP compounds
  - 2) Precipitation of crystals
- Handling properties**
- Hardening *in vivo***

## In this work...

- Optimization of:
  - Mechanical properties
  - Injectability



New Applications?

- Parameters to be studied:

- 1) Proportion of liquid phase (LP 30, 38, 42 & 50%)
- 2) Chitosan content (0%, 50% standard, 100% standard)



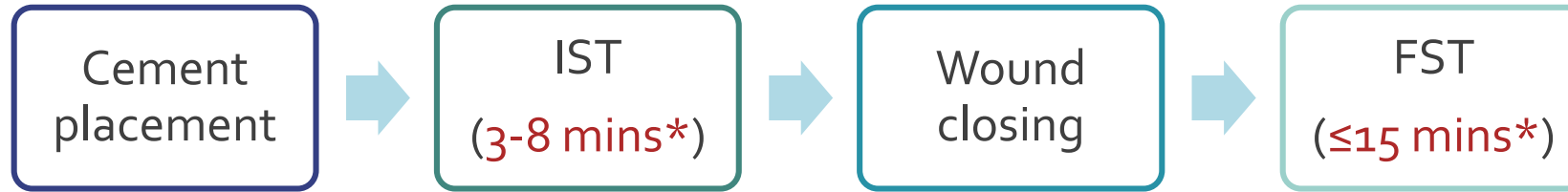
- Solid phase (62%): 2 calcium phosphates
- Liquid phase (38%): water + 2 compounds
- Adjuvant: chitosan

↓  
Hydroxyapatite

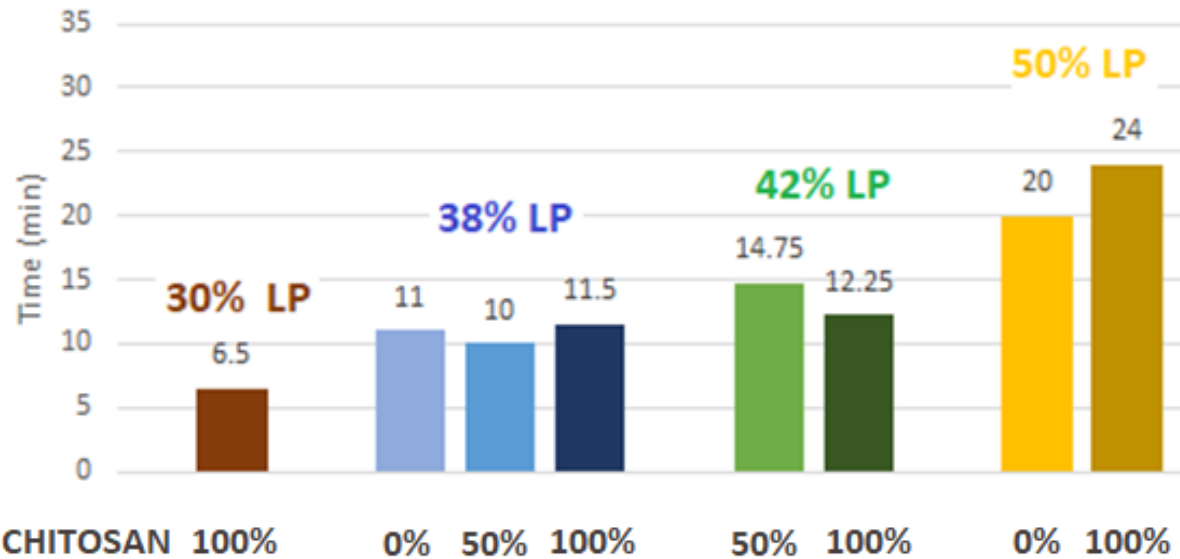




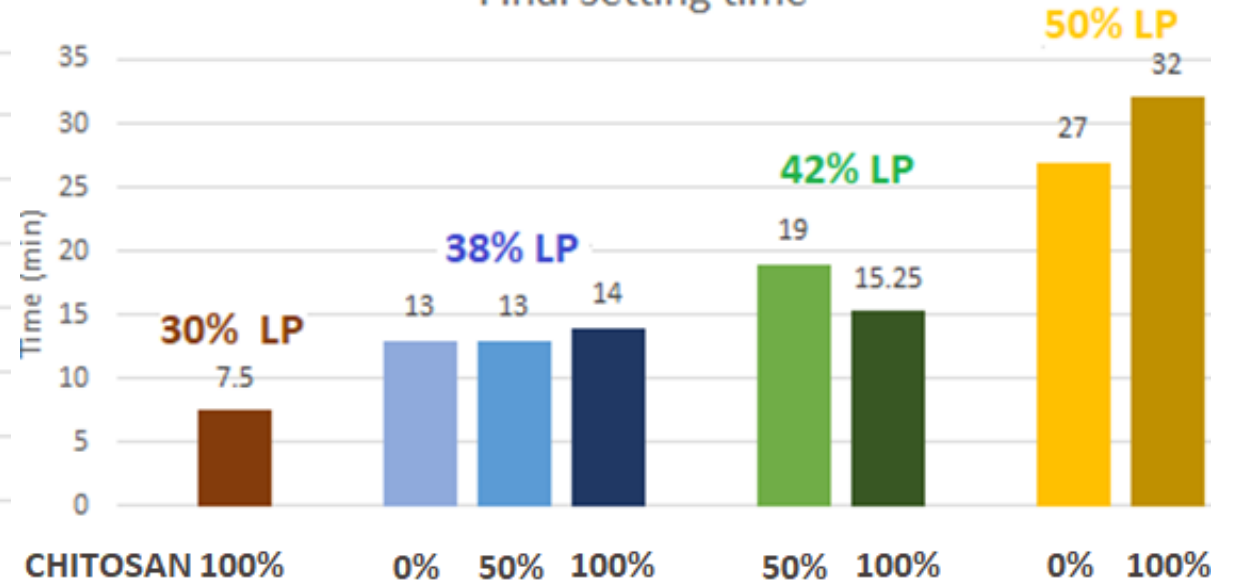
# Evaluation of the setting time



Initial setting time

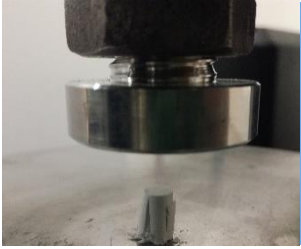


Final setting time



- Increases with LP
- Is not influenced by chitosan content

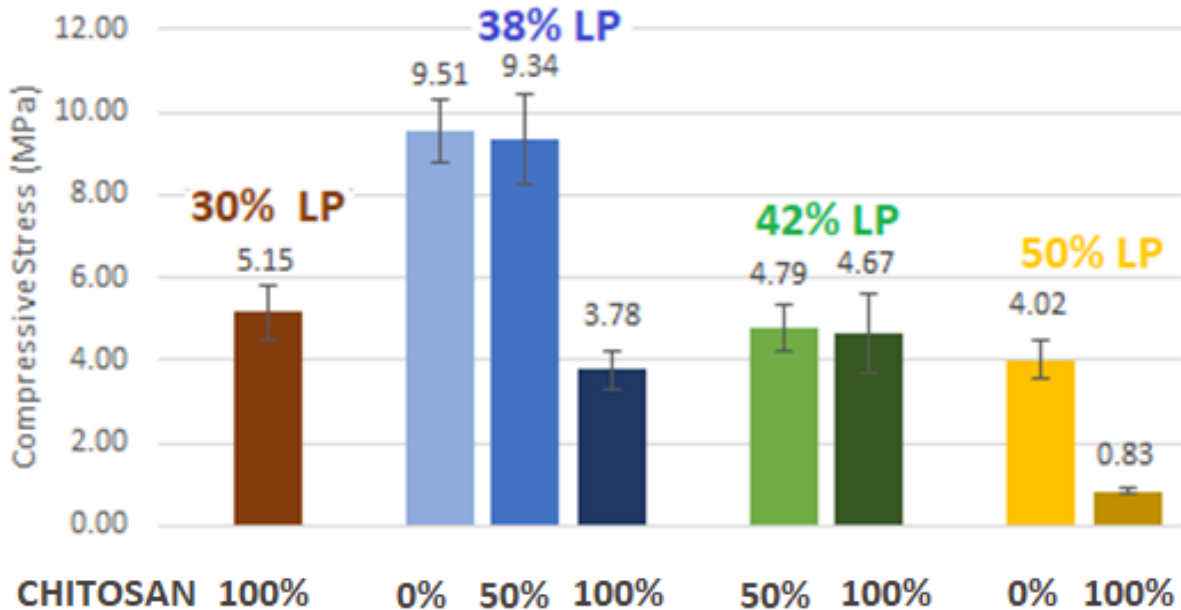
\*merely reference values



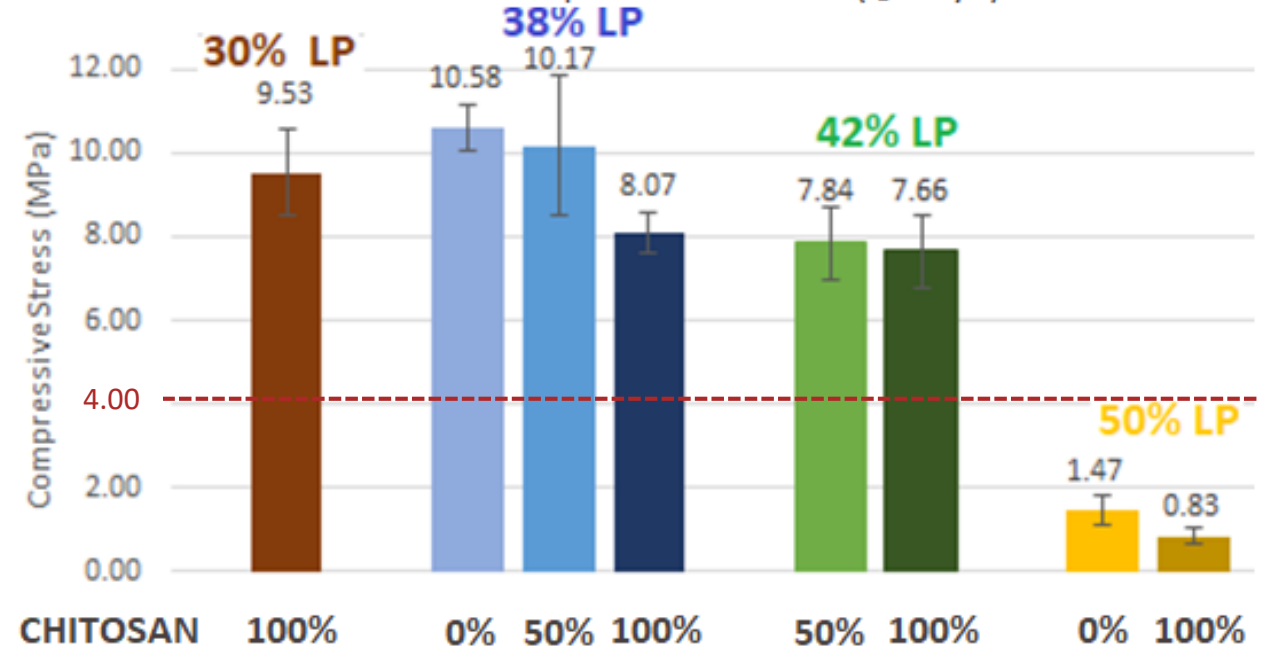
# Resistance to compression

- Setting occurred at 37°C and 95% RH, for 2 or 6 days
- Resistance to compression of human trabecular bone: 4-12 MPa

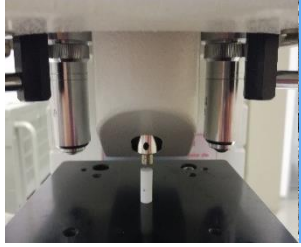
Maximum Compressive Stress (2 days)



Maximum Compressive Stress (6 days)



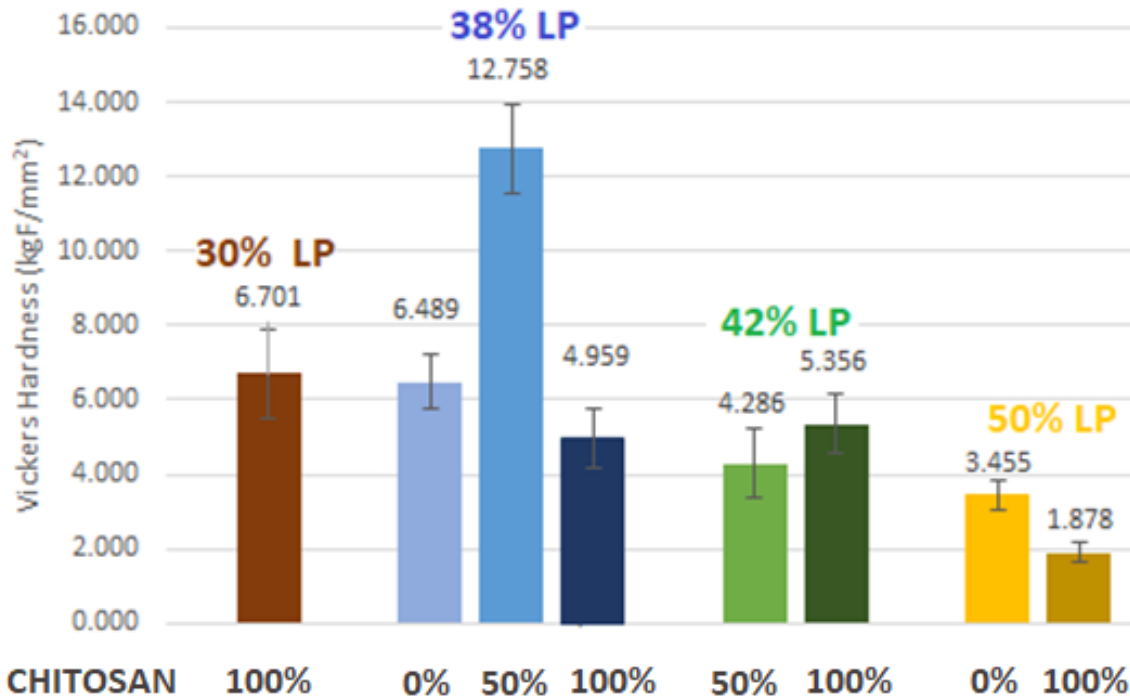
- Increases with incubation time
- Decreases with LP
- Is not influenced by chitosan content significantly



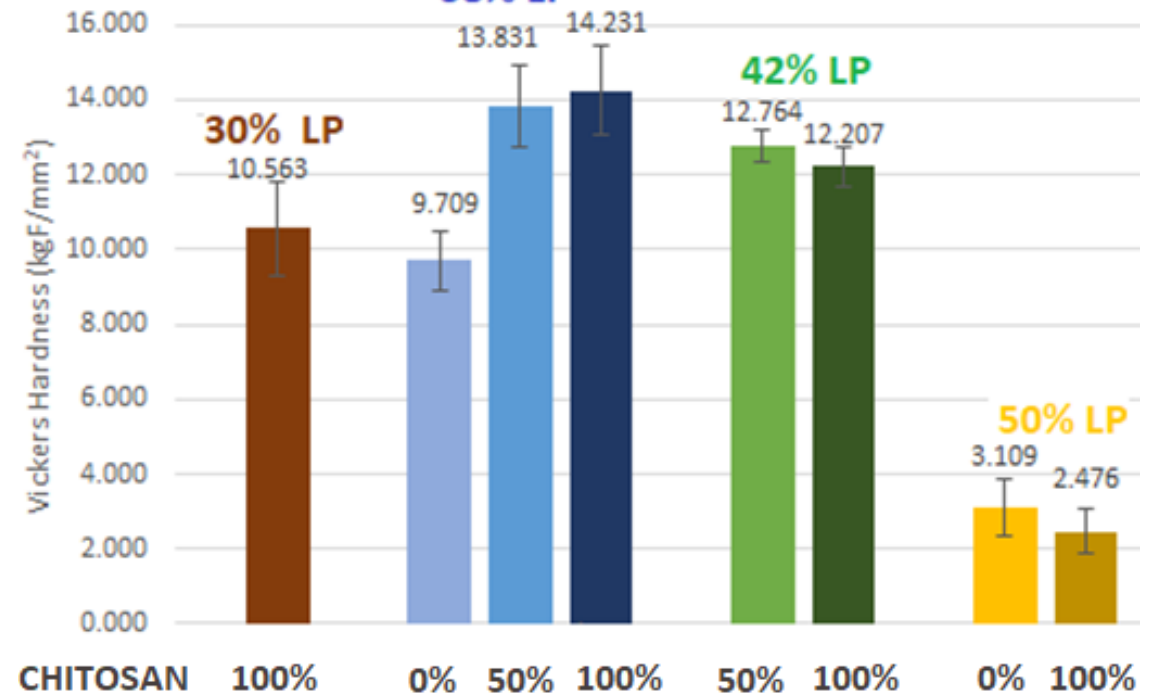
# Hardness of the materials

- Setting occurred at 37°C and 95% RH, for 2 or 6 days
- Vickers hardness of human trabecular bone: still to be tested under the same conditions

Vickers Hardness Tests (2 days)



Vickers Hardness Tests (6 days)



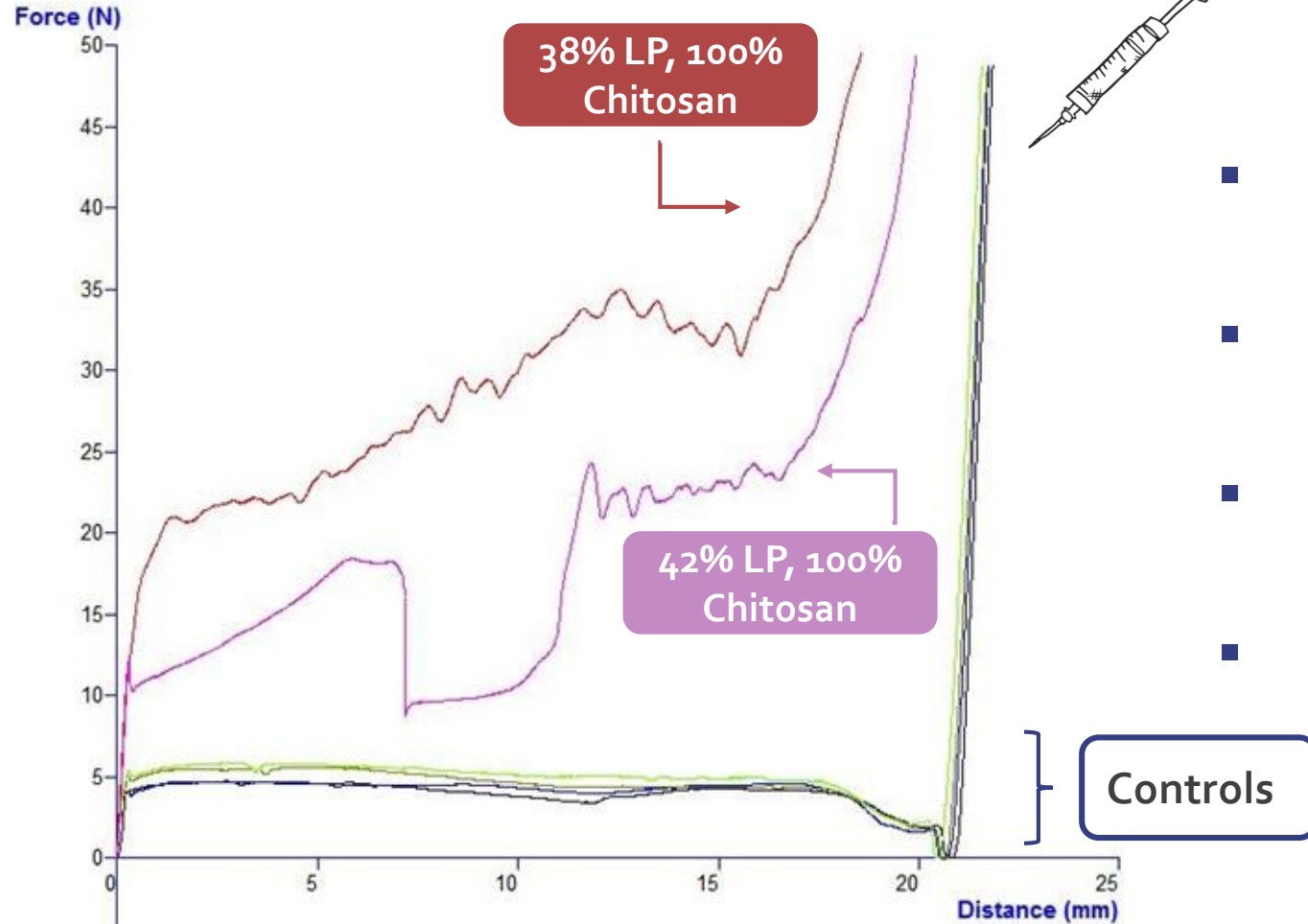
■ Similar patterns as before

■ These materials are much more harder than resistant

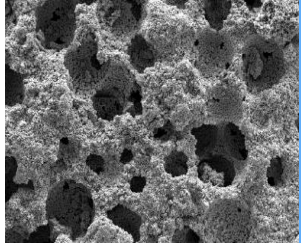




# Optimization of Injectability Measurements

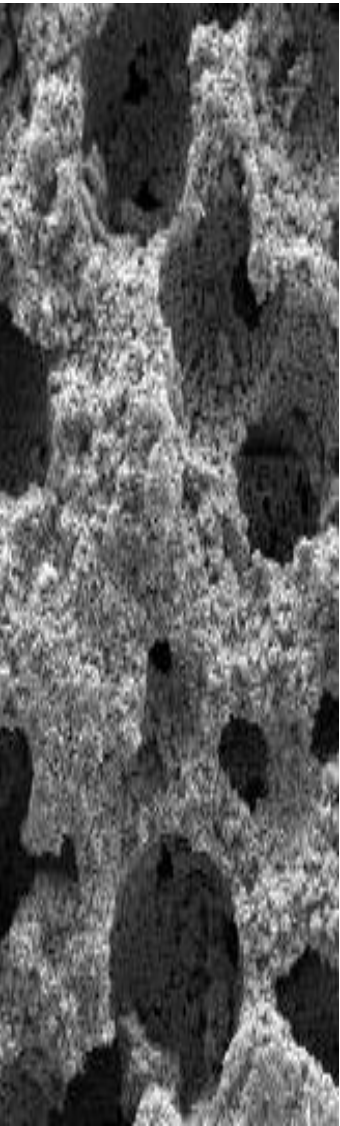


- Constant velocity of 15 mm/min
- Test Duration: 5 minutes
- The tested formulations are injectable
- 42%LP formulation is more injectable



# Conclusions

- LP content affects much more significantly the setting time and mechanical properties than chitosan content;
- Formulations with **LP42%** seem to be the most promising alternatives to Neocement<sup>®</sup> regarding setting time, resistance, hardness and injectability;
- Chitosan content might influence injectability and osteoinduction – requires further studies.



## Future work...

Another  
polymer  
(HPMC)

Mechanical  
Testing of  
Human  
Bone

Cell  
proliferation,  
adhesion &  
differentiation  
tests

Testing of  
wettability,  
porosity, etc

Loading with  
an antibiotic

**Thank you very much for your attention!**