Osteochondral Transplant System

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Overview

- Client Overview
- Problem Statement
- Background on Procedure
- Current Designs
- Design Ideas
- Design Matrix
- Future Work

Image Courtesy of: http://ptrefer.com/education/edu_inj/53/Articular_Cartilage_Injury__Osteochondral_defect

Client: Dr. Brian Walczak, DO

- Faculty, UW-Madison School of Medicine and Public Health

- Specialties:
  - Orthopedic Surgery
  - Pediatric Sports Medicine
  - Knee Arthroscopy

Walczak_Brian_DO.jpg

Problem Statement

- Osteochondral transplants are commonly used to correct defects in cartilage and bone tissue
- 20-25% chance of failure (Chahal, J, et al, 2013)
- Our Role:
  - Create a new system that reduces the forces applied to cartilage layer during insertion
  - Increase chondrocyte viability to decrease failure rate of procedure

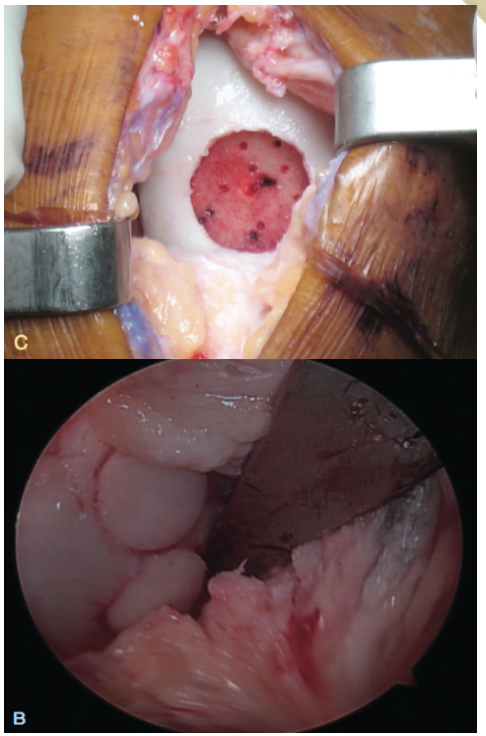


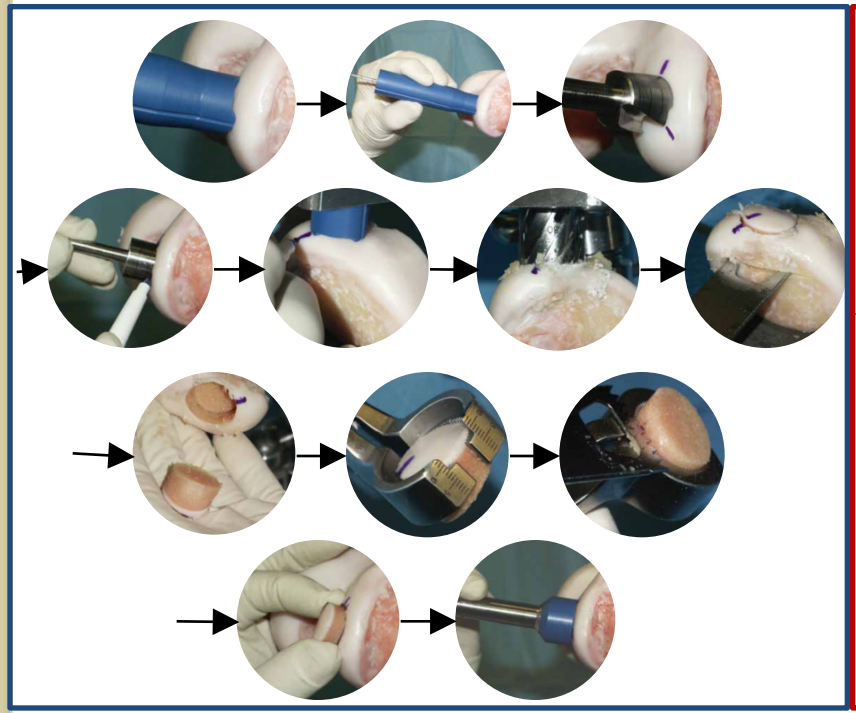
Figure 1: Graft recipient site (above) and inserted graft (below)[4]

Images Courtesy of: S. Akhavan, A. Miniaci, M. T. Provencher, C. B. Dewing, A. G. McNickle, A. B. Yanke, and B. J. Cole, "Cartilage Repair and Replacement: From Osteochondral Autograft Transfer to Allograft," in *SURGICAL TREATMENT OF THE ARTHRITIC KNEE: ALTERNATIVES TO TKA*, pp. 9–30.

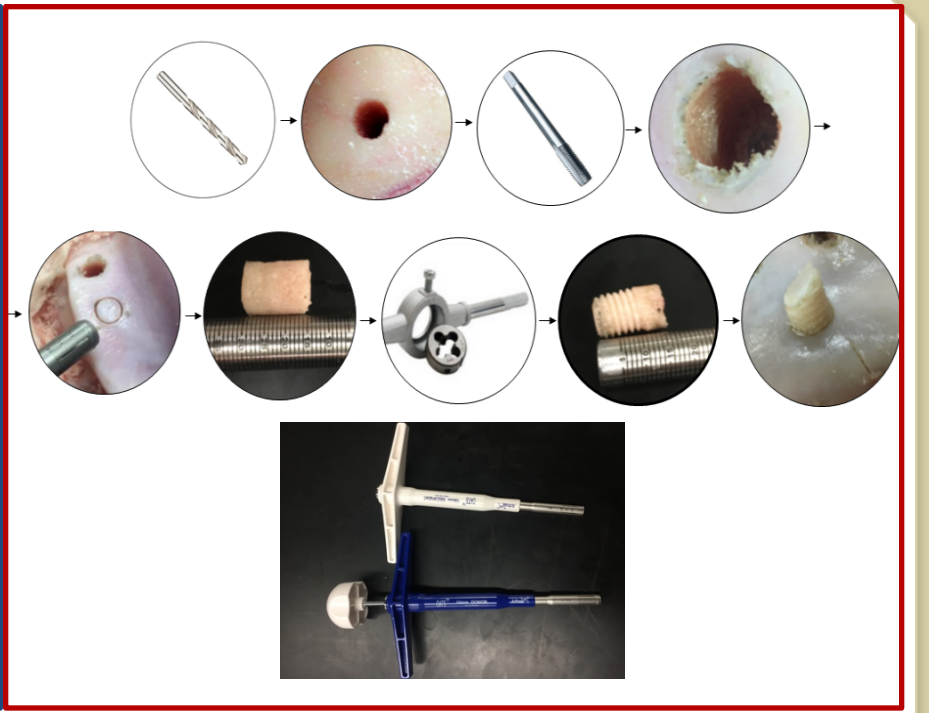
Product Design Specifications (PDS)

- Achieve more than 70% viability → impaction forces < 165 N during implantation (Walczak, et al, 2016)
- Graft must exhibit proper integration postoperatively
- Tools used in procedure should be capable of operating on bone
- Range of 5mm-20mm diameter and at least 10 mm depth for damage repair
- Materials should be sterilizable and comply with FDA regulations

Current Clinical Procedure[5]



Proposed Design Procedure



Reference: "ALLOGRAFT CARTILAGE TRANSPLANT SURGICAL TECHNIQUE," *MTF Sports Medicine*. [Online]. Available: https://www.mtf.org/documents/PI_-43_Rev_4.pdf. [Accessed: 16-Feb-2017].

Fluorescent Microscopy

- Stain
- Incubate
- Cryofreeze and Section thinly
- Image

Figure 2: Fluorescent Microscope[7]
Image Courtesy of http://www.spachoptics.com

Flow Cytometry

- Digest using collagenase
- Stain Cells
- Fix
- Run through flow cytometer
  - obtain live/dead numbers

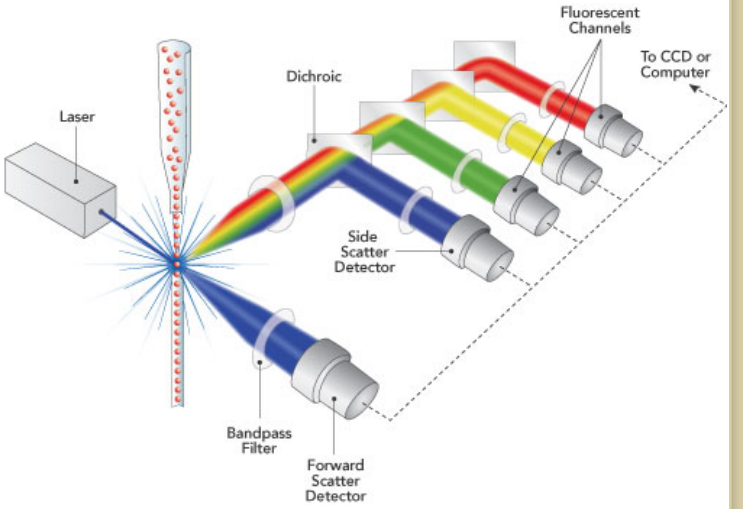


Figure 4: Flow Cytometer[8]
Image Courtesy of www.semrock.com

Confocal Microscopy

- Stain
- Incubate
- Fix and Section
- Image
  - Multiple layers

Figure 5: Confocal Microscope[9]
Image Courtesy of
http://www.immunohistochemistry.us

Design Matrix

Criteria	Fluorescent Microscopy		Flow Cytometry		Confocal Microscopy	
Accuracy (35)	(3/5)	21	(4/5)	28	(5/5)	35
Cost (30)	(5/5)	30	(1/5)	6	(4/5)	24
Ease of Use (20)	(5/5)	20	(2/5)	8	(3/5)	12
Tissue Section Prep (10)	(3/5)	6	(5/5)	10	(4/5)	8
Procedure Length (5)	(3/5)	3	(2/5)	2	(5/5)	5
Total	80		54		84	

Current Progress From Dec. 2016

Figure 1:
Threaded Bone plug

Figure 2:
Recipient holes

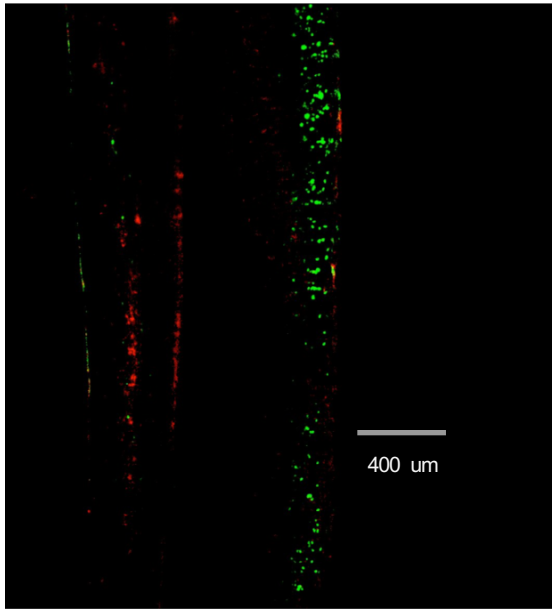


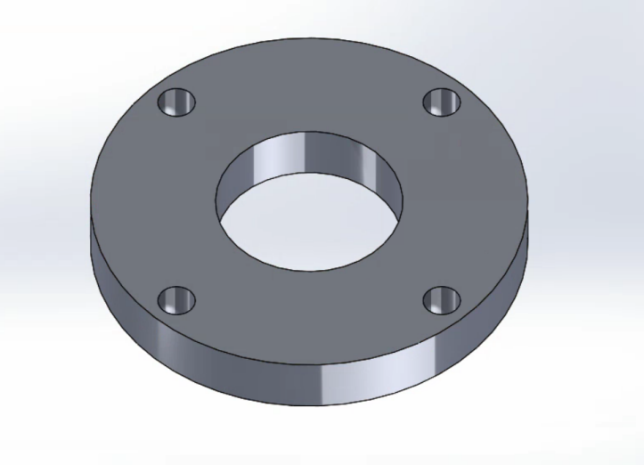
Figure 3: Live dead staining.

FITC (Live)

TRITC (Dead)

Future Work

- Fabricate a guide to accurately extract a plug
- Thread the plug
- Test compatibility with threaded recipient hole



Acknowledgments

- Dr. Saha
- Dr. Walczak

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