Osteochondral Transplant System

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Overview

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

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)

- Our Role:
    - Create a new system that reduces the forces applied to cartilage layer during insertion
    - Increase chondrocyte viability that would theoretically decrease failure rate

General Procedure

1.) Ream out section of damaged bone
2.) Create plug from donor tissue and shave down to exact size
3.) Insert into hole and into place
4.) Adjust as needed

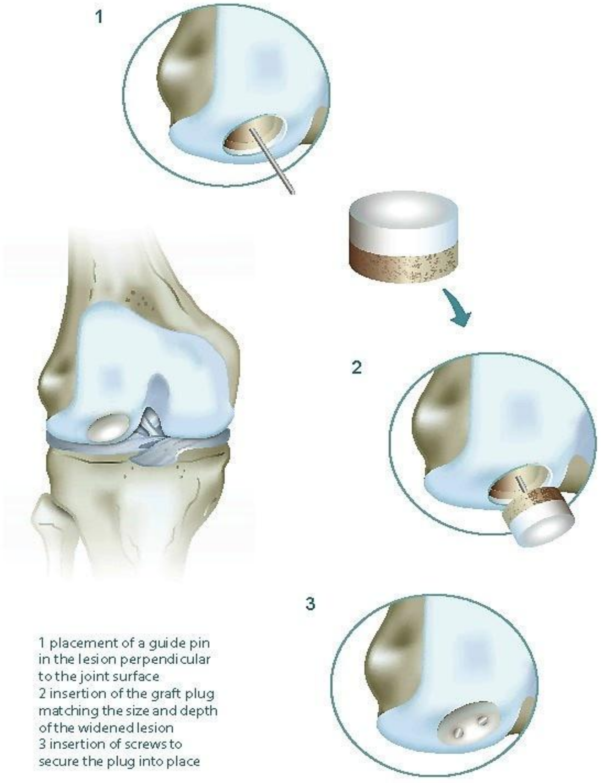


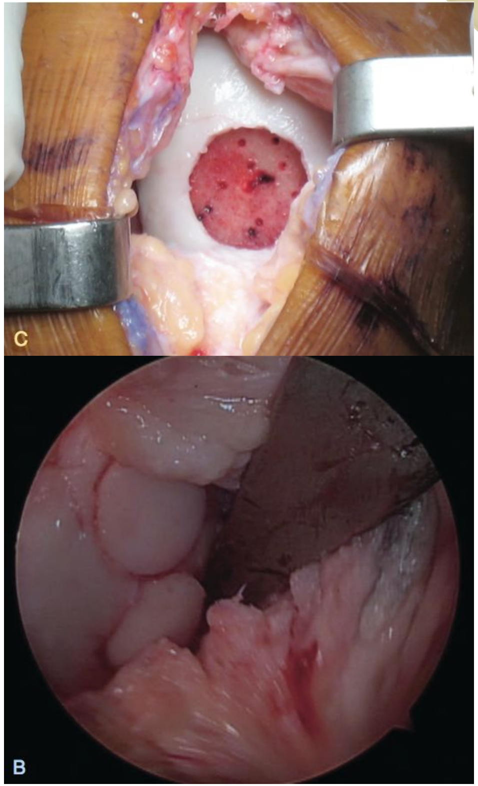
Fig. 024 Osteochondral allograft (OCA) transplantation

1 placement of a guide pin in the lesion perpendicular to the joint surface
2 insertion of the graft plug matching the size and depth of the widened lesion
3 insertion of screws to secure the plug into place

Current Methods

- Graft is placed in by hand with a press fit or if need be a small amount of impaction

- Impaction can have a negative impact on chondrocyte viability



Product Design Specifications (PDS)

- Must allow for >70% Chondrocyte viability after insertion, completed through decreasing forces used to insert graft into place (citation)
- Must not be more invasive or damaging than current procedure
- Should be as quick or shorter than current operating time of 5 hours, and not be more difficult to use than current surgical techniques
- Should improve success rate of surgery (currently 20-25% failure)
- Device should be sterilizable
- Must be completed within a budget of ($300)

Design Ideas

Suction Method

-Uses vacuum to generate
 twisting force

-Minimizes chondrocyte damage

-Must have on/off function

-Can utilize vacuum tubes in OR

-requires tap & die

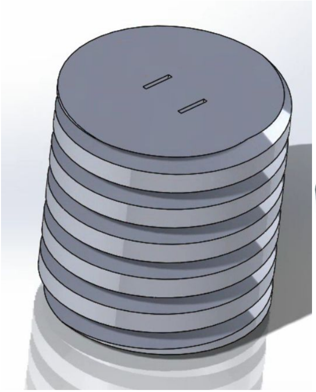
Design Ideas

Tine Insertion:

-Multiple inserted tines turn allograft

-Additional chondrocyte damage/cracks
-Complex gearing required for multiple drill shafts

-Tine diameter < 1/16 inches
-Still requires tap & die



Design Ideas

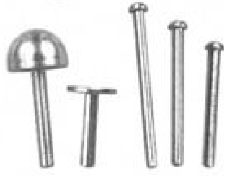
Synthetic Casing

-Similar to screw & anchor

-Integrates synthetic bone graft materials to facilitate bone reconstruction (hydroxyapatite, calcium phosphate, etc.)

-Requires novel insertion method

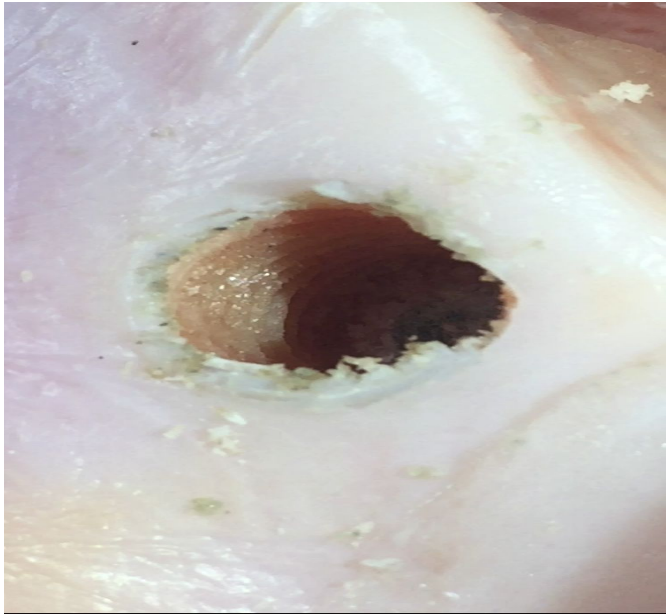
-Eliminates need to thread plug
-Scaffolds remain in patient after 10+ years



Design Matrix

Criteria	Design 1: Suction Screw		Design 2: Tine Screw		Design 3: Synthetic Casing	
Potential Chondrocyte Damage (25)	4/5	20	2/5	10	4/5	20
Procedure Length (20)	3/5	12	3/5	12	4/5	16
Ease of Use (18)	3/5	10.8	3/5	10.8	5/5	18
Sterilizability (15)	4/5	12	5/5	15	2/5	6
Adjustability (12)	5/5	12	3/5	7.2	2/5	4.8
Cost (10)	4/5	8	5/5	10	2/5	4
Total (100)		74.8		63		68.8

Current Progress



12M X 1.75 Tap used to thread 10 mm hole

Future Work

- Thread the plug and test its compatibility with threaded recipient hole
- Perform quantitative analysis of torsional forces required for implantation
- Assess the effects of torsional forces on chondrocyte and osteoblast viability

References

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3. 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.

4. S. L. Sherman, J. Garrity, K. Bauer, J. Cook, J. Stannard, and W. Bugbee, "Fresh Osteochondral Allograft Transplantation for the Knee: Current Concepts (vol 22, pg 121, 2014)," *Journal of the American Academy of Orthopaedic Surgeons,* vol. 22, no. 3, pp. 199-199, Mar 2014.