



Manikin Skywalker Joint Arthroscopy Manikin for Viable Cartilage

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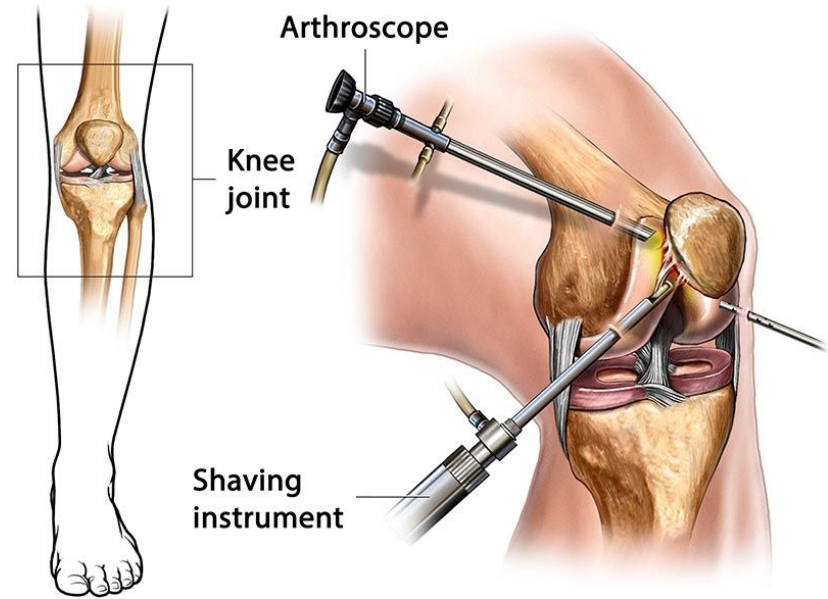
Dr. Russ Johnson

TA:

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Background

- Arthroscopy [1]
 - Minimally invasive
 - Arthroscope
 - Small incision
 - Complication risk <0.1%
- Redox balance [2]
 - Reactive Oxygen Species (ROS)
 - Natural buildup
 - Mitochondrial ETC byproduct
- Henak Lab
 - Low-cost
 - Anatomically correct manikin of knee
 - Ability to test live cartilage tissue
 - Competing devices- mainly training procedures



Healthdirect

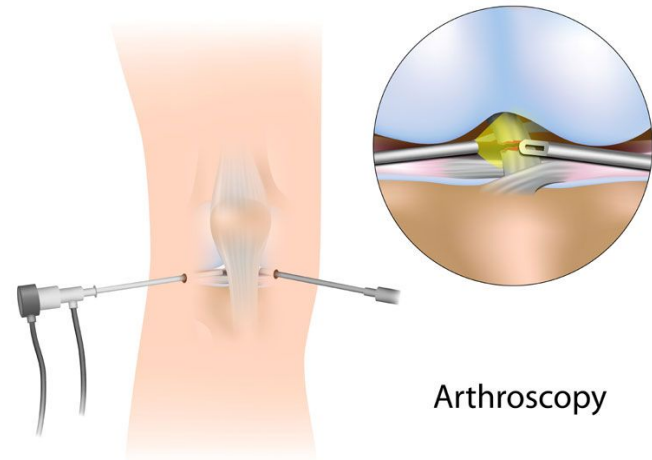
Problem Statement

- Problem
 - Health joint tissue evaluated purely visually
 - No system to measure redox imbalance
- If redox imbalance is known
 - Steroid injections to unhealthy tissue
 - Improved patient outcomes
- Requirements for Dr. Henak lab
 - Low-cost
 - Anatomically correct manikin of knee
 - Ability to test live cartilage tissue
- Current solution:
 - Do not allow for culture of live cartilage tissue
- Who is impacted
 - Dr. Henaks lab
 - Patients
 - Researchers



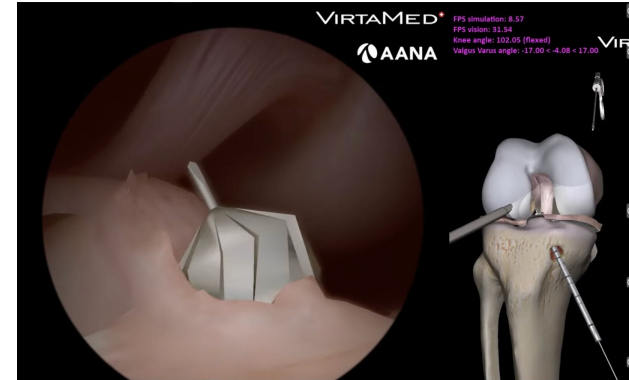
Stakeholders

- Patients
 - Patient welfare always highest priority in biomedical projects
 - 2 million patients yearly [3]
- Dr. Henak
 - Principal Investigator
 - Client and Faculty Consultant
 - Regular contact and feedback
- Research Community
 - Integrity of research
 - Accuracy
 - Reproducibility
 - Time and effort of other researchers

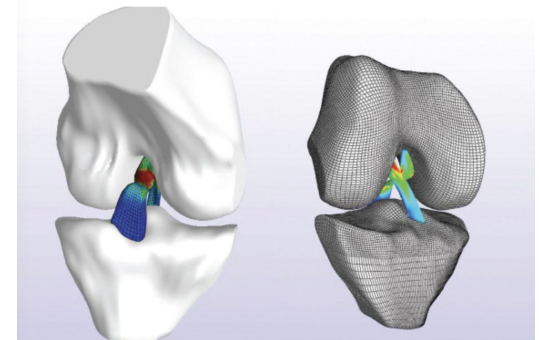


Knee Joint Model

- Anatomically Correct Patient Models [4]
 - Bones, ligaments, tendons replicated
 - Allow for variations in positioning during surgery
- Design Requirements
 - Bones of the knee should be anatomically correct
 - Ligaments included as needed for stability
 - Cartilage samples adequately attached
- Design Plan
 - 3D printed femur, tibia, fibula
 - Open Knee(s) from Cleveland Clinic
 - Cartilage sample glued or stapled to bone



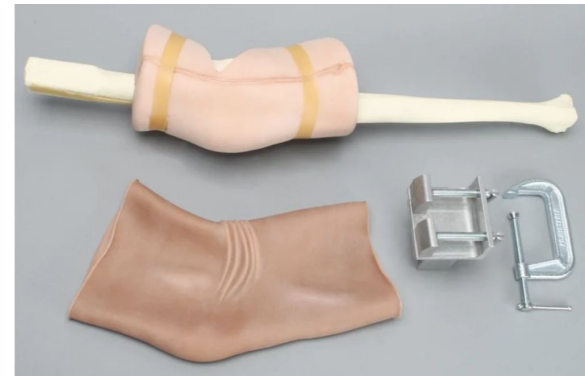
[5]



[6]

Enclosure

- Arthroscopic Manikin Enclosures
 - Existing Designs [7]
 - Solid interior allows for silicone sleeve
 - No need for sterility
 - No need for supplemental structure
- Design Requirements
 - Leakproof
 - Should allow access for scope
 - Made from biocompatible materials
 - Should secure joint structure
 - Ports for pump system



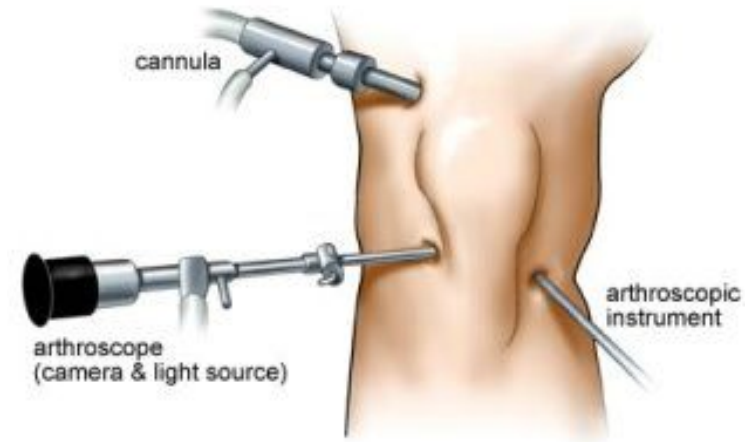
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Pump System

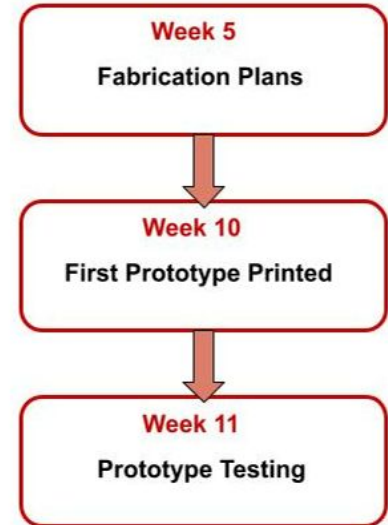
- Arthroscopic Pump Systems
 - Constant Fluid flow through the knee
 - Creates better visibility, maneuverability
- Design Requirements
 - 40 mmHg - 80 mmHg pressure range
 - 2-10% Oxygen concentration
 - Constant flow of media





Summary/Conclusion

- **Need**
 - Common procedure, requires practice to perfect
 - Culture of live cartilage tissue
 - Optically measure redox imbalance in real-time
 - Improve patient outcomes
- **Impacts**
 - Improve tissue health diagnostics
 - Improve patient quality of life
- **Plan of action**
 - Manikin involving 3 divisions: bone/joint, enclosure, pump
 - Prototype printed Week 10
 - Testing with surgeons





References

- [1] E. M. Berkson et al., “Knee,” in *Pathology and Intervention in Musculoskeletal Rehabilitation*, Elsevier, 2016, pp. 713–773. doi: 10.1016/B978-0-323-31072-7.00020-8.
- [2] J. Toro-Pérez and R. Rodrigo, “Contribution of oxidative stress in the mechanisms of postoperative complications and multiple organ dysfunction syndrome,” *Redox Rep. Commun. Free Radic. Res.*, vol. 26, no. 1, pp. 35–44, doi: 10.1080/13510002.2021.1891808.
- [3] S. G. F. Abram, A. J. R. Palmer, A. Judge, D. J. Beard, and A. J. Price, “Rates of knee arthroplasty in patients with a history of arthroscopic chondroplasty: results from a retrospective cohort study utilising the National Hospital Episode Statistics for England,” *BMJ Open*, vol. 10, no. 4, p. e030609, Apr. 2020, doi: 10.1136/bmjopen-2019-030609.
- [4] “VirtaMed ArthroSTM Knee.” VirtaMed, www.virtamed.com/en/medical-training-simulators/arthros/knee/. Accessed 04 Oct. 2023.
- [5] OrthoRheumEdit. (2017). Using Crowdsourcing to Revolutionize Knee Modeling. Retrieved from <https://consultqd.clevelandclinic.org/using-crowdsourcing-to-revolutionize-knee-modeling/>
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- [8] *DualWave™ Arthroscopy Pump*. Arthrex. (n.d.). <https://www.arthrex.com/imaging-resection/dualwave-arthroscopy-pump>



Questions?