NCIIA Grant Proposal

"Adaptable Retractor for Total Hip Replacement Surgery"

Vanderbilt University

Primary Investigator:
Dave Martinez
VP of Sales Zimmer, Inc

Applicants:
Jack DeLong
Biomedical Engineering Major
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Brian Rappa
Biomedical Engineering Major
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Lacey Gorochow
Biomedical Engineering Major
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Sandra Wadeer
Biomedical Engineering Major
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Adam Vandergriff
Biomedical Engineering Major
adam.c.vandergriff@vanderbilt.edu
Abstract

Current retractors used in total hip replacement surgery have a singular use that doesn't provide adequate vision for the surgeon in obese patients. Much of the soft tissue continues to cover the joint, obstructing the operation. The object of the design project is to produce multiple modular adaptors to existing retractors for a variety of patient sizes in order to

- Reduce cost
- Increase the vision and work room for the surgeon
- Produce functional modular adaptations ready for use in the operating room

Proposal Narrative

Introduction:

Total hip replacement surgery is a common surgical procedure to alleviate hip pain and loss of mobility. Arthritis and traumatic injury are the leading causes for chronic hip pain and joint disability. Currently in the United States more than 193,000 total hip replacements are performed each year (Orthoinfo). Similar surgical procedures are also performed on other joints, such as the knee, shoulder, and ankle. The procedure aims to reduce hip pain and increase joint mobility in order to improve the patient’s ability to perform common daily activities. The surgical procedure involves replacing the damaged femoral head and acetabulum with artificial hip prostheses, consisting of a femoral component and an acetabular component. Current tissue retractors being used in the surgical procedure ensure the surgeon has a clear field of vision, but there are a few complications. The retractors do not provide the surgeon with simple use and flexibility when dealing with excess soft tissue in the surgical area. A retractor adaptor for soft tissue protection and retraction is needed to facilitate orthopedic total hip surgical procedures.

History and Context:

Last year, one senior design team worked on a modular retractor for hip replacement. Their design consisted of an alterable handle length and blade depth, interchangeable handle types and tips for different patient physiological conditions, an ergonomic handle and an adipose tissue accessory. There were a total of four parts that attached together onto a single retractor to make the retractor adaptable to varying weights of patients who receive hip surgery. The group used Pro/Engineer to design their device. Although this group was able to implement a prototype made from plastic, we hope that our prototype will be more complete and made of stainless steel that will ultimately be tested by a local surgeon.
Work Plans and Outcomes:

The end goal of the project is to produce a retractor tool that will aid in total hip replacement surgery. The tool will need to be able to be adjusted to suit different patient physiological conditions so that all of the soft tissue surrounding the joint can be held back while the surgery takes place. The purpose of the tool is to allow for more efficient surgical procedures while reducing the likelihood of harm to the patient.

Timeline:

<table>
<thead>
<tr>
<th>Month</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 2010</td>
<td>Multiple preliminary designs.</td>
</tr>
<tr>
<td>February 2010</td>
<td>Selection of final design that will be developed</td>
</tr>
<tr>
<td>March 2010</td>
<td>ProE design finished</td>
</tr>
<tr>
<td>April 2010</td>
<td>Production of a working prototype</td>
</tr>
</tbody>
</table>

Team:

Our team consists of the following individuals: Sandra Wadeer, Lacey Gorochow, Adam Vandergriff, Brian Rappa, and Trey Delong, and all five members are biomedical engineering majors who have some interest in orthopedics. Our team leader is Trey Delong and our contact person is Lacey Gorochow. For this project, Brian Rappa will be the main person responsible for conducting the research behind hip retractors device, and Sandra Wadeer and Lacey Gorochow will assist him as needed. Sandra Wadeer and Lacey Gorochow will be in charge of using Pro/Engineer software to design and help create a prototype of the hip retractor device. Once we have enough information we plan on having Adam Vandergriff and Trey Delong work on writing the technical paper and presentation of the overall project.

Evaluation and Sustainability Plan:

Our goal for the project is to develop a prototype of the hip retractor device that will eventually be used in total hip replacement surgery, so we will measure our success on the completion of the prototype. Additionally, we will measure our success based on the amount of work each group member puts into the project to make our goal of producing the retractor prototype a reality.
Appendix

Budget:

<table>
<thead>
<tr>
<th>Project Title:</th>
<th>Institution: Vanderbilt University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expense Category</td>
<td>Amount</td>
</tr>
<tr>
<td>Travel Expenses</td>
<td>$50</td>
</tr>
<tr>
<td>Prototyping</td>
<td>$500</td>
</tr>
</tbody>
</table>

Justification:

Travel expenses are included to account for the gas money needed to drive the group to St. Thomas Hospital to view total hip replacement surgeries. These viewings are essential to the team’s understanding of how the surgeon works with present retractor device during surgery. Trips will also be made to St. Thomas when we have a working prototype that can be tested out by the surgeon. The cost for prototyping is estimated to be $500 based on the machine shop time needed and the cost of the material from which the device is made.

References:
Orthoinfo: http://orthoinfo.aaos.org/topic.cfm?topic=a00377
SANDRA WADEER
sandra.a.wadeer@vanderbilt.edu

CURRENT ADDRESS
VU Station B 351356
2301 Vanderbilt Place
Nashville, TN 37235

PERMANENT ADDRESS
2 Theresa Drive
Flanders, NJ 07836
Mobile: (973) 960-4229

EDUCATION
Vanderbilt University, Nashville, TN
Bachelor of Engineering May 2011
Major: Biomedical Engineering

INTERN EXPERIENCE
Colgate-Palmolive Company Piscataway, NJ
Research and Development - Early Research, Oral Care Summer Intern 2010
- Formulated mouthwash base in order to post add active ingredients
- Determined antibacterial efficacy of new active ingredient in mouthwash
- Evaluated fresh breath efficacy of new active ingredient in mouthwash

RESEARCH PROJECT
Analysis of Bone – Vanderbilt Center of Bone Biology Nashville, TN
Micro-Computed Tomography and Biomechanics Summer Research 2009
- Embedded femurs in plastic from wild-type mice and mice lacking BMP-2 gene
- Cut, ground and polished sections of embedded femurs for Raman and Nano Indentation
- Evaluated trabecular bone from the metaphysis with and without osteolytic tumors
- Analyzed results from micro-CT Finite Element Models of mouse vertebral bodies
- High Performance Liquid Chromatography analysis of collagen cross links in mouse bones

WORK EXPERIENCE
Vanderbilt University Science and Engineering Library
Undergraduate Library Assistant Fall 2009 – Spring 2010
- Charge and discharge library materials, collect and record fines
- Give directional information, search books and overdue, shelve books, periodicals, maps
- Provide technical support to customers and interaction with library users

Verizon Wireless Subpoena Compliance Group Bedminster, NJ
Data Entry Logger Spring 2008
- Analyzed subpoenas from all over country to determine if compliant with regulations
- Logged relevant information into companies computer system
- Answered telephones, provided customer service, scanned information, worked in mailroom

LEADERSHIP EXPERIENCE
In Christ Youth Ministries Ensenada, Mexico
Missionary Summer 2008
- Taught English as Second Language to local children ages 6-12
- Built addition onto home for family of six
- Aided in restoration of local church by painting, spackling, renovations

Nashville Rescue Mission Nashville, TN
Volunteer Summer 2009
- Served dinner to the homeless

RELEVANT COURSEWORK
- Analysis of Biomedical Data
- Biomaterials
- Biomechanics
- Circuit Analysis
- Medical Instrumentation
- Nanobiotechnology
- Physiological Transport
- Systems Physiology

HONORS AND ACTIVITIES
- Dean’s List, Spring 2009
- Vanderbilt Cares, Special Events Chair
- Society of Women Engineers
- Lambda Theta Alpha Latin Sorority, Incorporated
- African Student Union, Secretary, Fall 2007
- V-Squared Mentor, Fall 2009
- In Christ Youth Ministries, Missionary in Ensenada, Mexico Summer 2008
Class experience

(ES140) Introduction to Bio engineering
- Gained exposure to many fields of biomedical engineering, i.e. rehab, imaging, and medical practice
- Introduced to the forms of medical imaging, as well as gained a good understanding in both their functioning and uses
- Used real images, along with Matlab analysis identify various medical conditions.

(ES101) Rehab engineering
- Learned about many fields in rehab engineering (prosthetics, wheelchair design)
- Designed a functional prosthetic for a disabled child.

(CS103) Matlab Programming
- Experience with designing programs for data and image analysis.
- Experience in writing elementary programs including graphic-user interfaces

(BME101) Biomechanics
- Comprehensive class that focused on Newtonian forces as applied to the body
- Work in the musculoskeletal function, and application of orthopedics and joint replacements.
- Used Matlab to create stress models of joints and muscles.

(BME103) Biomaterials
- Work in the various forms of implantable materials (ceramics, metals, and polymers).
- Study the physiological responses to surgery and implantation.

Internship (Philips Medical)
- Worked in ultrasound department
- Gained skills in computer networking, medical applications and design for imaging equipment, design and functional repair of ultrasound machines
Projects & Activities

- Team leader for a systems engineering group responsible for redesigning the patient whiteboard (tracks patient location and waiting times) in the Henry Joyce Cancer Clinic in order to optimize clinic efficiency.
- Member of a project management team responsible for analyzing several opportunities to expand Vanderbilt Dining. Included in-depth cost analysis, market research, and architectural design and implementation plan.
- Member of a team that designed an extendible prosthetic arm for a disabled child.
- Living and Learning Mayfield resident for a year. Project focused on Veteran Care including sending care packages, volunteering at the VA, and hosting veteran speakers.
- Member of Alpha Tau Omega Fraternity, Beta Pi chapter.
- Worked at the Muscular Dystrophy Association lock-up for 4 years.

Education

Major: Biomechanical Engineering (2.97 GPA)  
Senior  
Vanderbilt University, Nashville, TN

Minor: Engineering management

References

Charles Allen(Philips Medical Head of Intern program)  
770-407-0481
Lacey E. Gorochow  
Lacey.e.gorochow@vanderbilt.edu

Current Address:  
2301 Vanderbilt Place  
VU Station B 0638  
Nashville, TN 37235

Permanent Address:  
11104 S. Glen Rd  
Potomac, MD 20854  
240-638-6144

EDUCATION
Vanderbilt University, Nashville, TN  
Bachelor of Engineering, Biomedical Engineering  
GPA: 3.1/4.0, Dean’s List Spring 2010

Danish Institute for Study Abroad, Copenhagen, Denmark  
Selected to participate in program with coursework focused on HIV/AIDS in Europe: Biomedical Perspectives and Public Health Perspectives  
May 2011

RELEVANT COURSEWORK
• Biomedical Instrumentation
• Therapeutic Bioengineering
• Design of Biomedical Engineering Devices & Systems
• Computer Aided Design
• Systems Physiology
• Nanobiotechnology

RELEVANT PROJECTS
Differential effects of modest dehydration on the toughness of young and old bone  
• Compute and analyze toughness, mineral density, porosity and water content of young and old bone using tensile test, micro-CT, and thermal gravimetric analysis.  
Fall 2010

Synthetic cartilage as a knee replacement biomaterial application  
• Proposal to fabricate a synthetic cartilage to help improve osteoarthritis  
Spring 2010

AWARDS
Sycamore. US Scholarship Winner  
Fall 2007

Distinguished Maryland Scholar  
Fall 2006

WORK EXPERIENCE
Spine and Bone Biomechanics Lab at Vanderbilt University Medical Center, Nashville, TN  
Research Assistant  
• Investigated aging effects on human bone using biomechanical testing, micro-CT and Raman Spectroscopy  
Summer 2010

Project C.U.R.E., Nashville, TN, Volunteer  
• Maintained and repaired donated medical equipment including oxygen concentrators, operating room tables, and defibrillators to ensure proper functioning for shipment to developing countries  
Summer 2010

Visionary Institute for Total Ageless Living, Inc., Potomac, MD, Intern  
• Created database of cities ideal for baby boomers to live and work  
• Researched potential sponsors and funding opportunities to help non-profit grow  
Summer 2009

Cassidy & Pinkard Colliers, Rockville, MD, Receptionist  
• Managed front desk at firm’s headquarters  
Summer 2009

ACTIVITIES
VandyCares, Education Chair  
• Coordinate HIV/AIDS awareness events in Vanderbilt community  
• Designed curriculum to educate middle and high school students on facts and common misconceptions of HIV/AIDS in Nashville community center  
Fall 2009-present

Global Education Office, Student Ambassador for Copenhagen, Denmark  
• Selected to assist prospective students interested in studying abroad in Copenhagen by answering their questions and assisting students with application process  
Fall 2009-present

Alpha Chi Omega, Member  
• Helped to organize benefit events used to raise funds and consciousness for Domestic Violence Awareness and YWCA of Nashville and Middle Tennessee  
Spring 2008-2010

Society of Women Engineers, Sig-Figs Mentor  
• Promote advent of women engineers through offering academic advice to high school female students wanting to pursue education in engineering field  
Fall 2007-present

SKILLS
LabView, MATLAB, Mathematica, OSX Mac and PC knowledge, Pro/Engineer 5.0, R (Statistics Programming Language)
Brian Alexander Rappa  
Brian.a.rappa@vanderbilt.edu

Current Address  
2301 Vanderbilt Place  
VU Station B #6933  
Nashville, Tennessee 35235

Permanent Address  
277 Plantation Hill rd.  
Gulf Breeze, FL 32561

EDUCATION

- **Vanderbilt University**, Nashville, TN May 2011
- **Bachelor of Engineering in Biomedical Engineering**
- **Minor in Philosophy**

Course Projects

Biomedical Instrumentation – *created medical devices such as an ECG*

Biomedical Optics – *design and set up of laser systems applicable to medicine*

HONORS

- Dean’s List
- Full tuition Army ROTC scholarship

LEADERSHIP ACTIVITIES

- Army Reserved Officer Training Corps.
  - Battalion S3 responsible for the planning and execution of all training events (August 2009 – May 2010).
- Air Assault School graduate: qualified for combat repels from UH-60 Blackhawks.
- Leadership Development and Assessment Course (June 2010)
  - Graduated with overall evaluation of “Excellent”
  - Ranked top 11% of Regiment

SKILLS/ABILITIES

- MATLAB
- LabView
- Mathematica
- Microsoft Office (Word, Excel, Powerpoint, Access, Expressions Web)

Extracurricular

- Intramural Flag Football (2007-2010)
- Intramural Soccer (2007-2010)
- Biomedical Engineering Society (2007-2010)
Adam Vandergriff
VU Station B PO Box 2478 ◆ Nashville, TN, 37235 ◆ (423) 364-0956 ◆ adam.c.vandergriff@vanderbilt.edu

Education

VANDERBILT UNIVERSITY – NASHVILLE, TN
Bachelor of Engineering in Biomedical Engineering, May 2011
GPA: 2.67/4.0
Have taken elective courses in Medical Imaging and Biomedical Service and Leadership
Theta Tau professional engineering fraternity

BAYLOR SCHOOL – CHATTANOOGA, TN
High School Degree, June 2007
GPA: 3.88/4.0
National Honor Society, Cum Laude, Varsity Letter (Rowing)

Research

VANDERBILT UNIVERSITY BIOMEDICAL OPTICS LABORATORY
◆ Ongoing research project in beginning stages (Current)

VANDERBILT UNIVERSITY INSTITUTE OF IMAGING SCIENCE
◆ The utility of fluorophore-based fiber optic sensors for measuring variations in tumor oxygenation (Fall 2009)

Skills Summary
◆ Mathematica ◆ Matlab ◆ Computer Savvy

Community Activities

ALTERNATIVE SPRING BREAK
◆ Provided Assistance and Service at Good Works Inc. (Spring Break 2010)

MEMORIAL HOSPITAL VOLUNTEER
◆ Assisted in transporting patients, relayed information from operating room to patient’s family, and helped prepare table in interventional radiology (Summer 2009)

MIDWINTER'S NIGHTS BLAST
◆ Percussionist in concert to raise money for school’s community service program (2007)

Employment History

VANDERGRIFF & WILSON LAWN SERVICES – CHATTANOOGA, TN
Co-Owner/Worker, Summer 2008

ENCORENATIONWIDE – Various Locations
Brand Ambassodor, 2007-Present (seasonal)

Awards
◆ Eagle Scout
◆ Brotherhood Member of The Order of the Arrow