Project Title:

A rechargeable, handheld, digital torque screwdriver with interchangeable Synthes orthopedic head attachments that can be sterilized for use in surgical repair of equine long bone fractures. The preliminary model would just require a 4.5 mm hexagonal head to fit a 4.5 mm cortical bone screw. In time we would also like to set-up for 3.5 mm and 5.5 mm cortical bone screws.

Project Description:

Bone exhibits viscoelastic behavior. Stress depends not only on the strain but also on the time history of the strain. Such behavior can manifest itself as creep, which is a gradual increase in strain under constant stress and stress relaxation, which is a gradual decrease in stress in a specimen held at constant strain. After placement of bone screws, this behavior can influence insertional torque and torque relaxation, which is an important and poorly understood phenomenon.

Unlike smaller animals or human patients, long bone fracture constructs in horses experience substantial loading during recovery from general anesthesia immediately after fracture repair. After surgery, horses will typically apply substantial static loads to the construct, as they cannot stand or walk on three limbs. Therefore, the fracture-implant construct needs to be as strong as possible mechanically to allow the fracture to heal successfully without implant breakage or loosening. During orthopedic surgery, bone screws are typically tightened to a subjective torque value by the surgeon during placement. Despite reported ranges of optimal torque in the literature, there is no definitive standardized optimal tightening torque values that reflect potential torque relaxation of bone screws after insertion in bone in equine patients undergoing fracture repair.

The UW School of Veterinary Medicine, Department of Surgical Sciences and the School of Mechanical Engineering will be conducting a pilot study to establish insertional torque values and torque relaxation for 4.5 mm cortical bone screws inserted into equine third metacarpal (MCIII) bones. The specific aims of this project are: 1) To determine if torque relaxation of 4.5 mm unicortical and bicortical cortical bone screws in equine MCIII changes over time; 2) To determine whether torque relaxation is influenced by use of unicortical and bicortical cortical bone screws; and 3) To determine whether torque relaxation is influenced by anatomical location in the diaphysis of the MCIII bone. The values determined in this preliminary static pilot study will then be used to conduct future dynamic testing. By studying torque relaxation after screw placement, optimal torque settings for 4.5 mm cortical bone screw fixation in equine MCIII bones can be established. This approach to fracture repair is expected to result in stronger fracture constructs after surgery and enhanced clinical outcomes.

For the purposes of this pilot study, we will require a handheld digital torque measuring and limiting screwdriver with a Synthes 4.5 mm hexagonal screwdriver head to fit a 4.5 mm cortical bone screw. The screws will be placed in MCIII bones collected from horses euthanatized for reasons unrelated to thoracic limb lameness. Based on preliminary literature reviews, we have determined that the screwdriver would need to measure and limit torque forces between 1 and 10 Nm, with a range up to 20 Nm. Our long-term goal is to design and engineer a digital torque screwdriver for use in clinical patients during implant placement for fracture repair. Our research ex-vivo data on torque relaxation can then be translated into the clinic and used to optimize the insertion torque of bone screws during clinical surgery. Thus, ultimately, the device would need to be rechargeable, handheld, and sterilizable, with interchangeable heads to fit other sizes of Synthes orthopedic screws that are used clinically in veterinary patients.
Materials/Supplies Available:

We have example Synthes 4.5 mm, 3.5 mm and 5.5 mm screw drivers and bone screws available for use in this design project and other surgical instruments that may be relevant to the work.

Relevant Journal Articles/Websites:


**Equine fracture repair equipment:**


http://us.synthesvet.com/45mm-Cortex-Screws-C143.aspx

**Torque measuring screwdrivers and gauges used in other studies for your review:**


http://www.grainger.com/category/hand-tools-screwdrivers-and-nutdrivers-torque-screwdrivers/ecatalog/N-98p/Ntt-Torque+Screw+Driver?s_kwcid=AL%212966%213%218426942990%21b%21g%21torque+screw+driver&sst=subset&ts_optout=true


https://www.transducertechniques.com/torque-sensor.aspx

http://www.mountztorque.com/learning-center/mountz-tls-torque-screwdriver

Skills project likely to include*:
- Animal Experiments
- Biomaterials
- Cell Biology
- Chemistry
- Electronics
- Human Subjects
- Imaging
- Mechanics
- Software
- Tissue Engineering
- Other:

Budget*:
Students typically need at least $100 for parts and materials.
We have applied for extramural research grants to support this research. We currently have access to sufficient pilot funds that can support development of the torque measuring/limiting screw driver in consultation with the design team.

Do you think that your project has potential intellectual property that needs to be protected?
Successful completion of this design project will lead to submission of an Invention Disclosure Report to the Wisconsin Alumni Research Foundation for review and potential patenting. We expect that DePuy Synthes Vet or other leading orthopaedic surgical implant companies will wish to license this intellectual property and incorporate it into their surgical instruments over time.

Client
Sabrina Brounts, DVM, MS, DACVS, DECVS, DACVSMR
Section Head, Associate Professor Large Animal Surgery
UW School of Veterinary Medicine
Sabrina.brounts@wisc.edu

Jennifer Whyard, BVetMed MRCVS
Large Animal Surgery Resident
UW School of Veterinary Medicine
Jennifer.whyard@wisc.edu

Peter Muir BVSc, MVetClinStud, PhD, Diplomate ACVS, ECVS