SECTION B

See the Technical Exhibits listing on page 10

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Kappa Delta, OREF winners honored today

The winners of the 2007 Kappa Delta Awards and the Orthopaedic Research and Education Foundation (OREF) Clinical Research Award will be recognized today during the Opening Ceremonies of the AAOS Annual Meeting.

The 2007 Kappa Delta Young Investigator Award is Constance R. Chu, MD, who outlined her career in "Integrating Bench to Operating Room: Journey of a Clinician-Scientist."

Recipients of the Kappa Delta Ann Doner Vaughan Award are David L. Butler, PhD, Natalia Juncosa- Melvin, PhD, Gregory P. Boivin, DVM, Marc T. Galloway, MD, Jason T. Shearn, PhD, Cynthia Gooch, BS, and Hani Awad, PhD, for their research on "Functional Tissue Engineering for Tendon Repair: A Multidisciplinary Strategy using Mesenchymal Stem Cells, Bioscaffolds and Mechanical Stimulation."

Winners of Kappa Delta's 2007 Elizabeth Winston Lanier Award are Martha L. Gray, PhD, and coauthors Deborah Burstein, PhD, Young-Jo Kim MD, PhD, and Alice Maroudas, PhD, for their paper on "Magnetic Resonance Imaging of Cartilage Glycosaminoglycan: Basic Principles, Imaging Technique, and Clinical Applications."

The work of Christian Gerber, MD, FRCSEd(hon) on "Rotator Cuff Disease: From Scientific Understanding to Patient Care" will be honored with the 2007 OREF Clinical Research Award.

Continued on page 3

Christian Gerber, MD, FRCSEd(hon) (right, front) will receive the 2007 OREF Clinical Research Award for his work on "Rotator Cuff Disease: From Scientific Understanding to Patient Care." (see complete story, page 32)

Tendon repair strategy receives Ann Doner Vaughan award

David L. Butler, PhD

By Sally Chapralis

David L. Butler, PhD; Natalia Juncosa-Melvin, PhD; Gregory P. Boivin, DVM; Marc T. Galloway, MD; Jason T. Shearn, PhD; Cythia Gooch, BS; and Hani Awad, PhD, have received the 2007 Ann Doner Vaughan Award for their research and manuscript on "Functional Tissue Engineering for Tendon Repair: A Multidisciplinary Strategy Using Mesenchymal Stem Cells, Bioscaffolds and Mechanical Stimulation."

The team's research has significant clinical implications. They note that patients sustain more than 32 million traumatic and repetitive motion injuries to tendons and ligaments, and that the aging of the population is expected to result in more (and more severe) tendon injuries, dramatically affecting a patient's quality of life.

As their manuscript explains, tissue engineering has the potential to

Continued on page 2

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Multimedia Education Center features orthopaedic video education

By Reid Stanton

The Multimedia Education Center at the Annual Meeting is a great place to visit whenever your schedule permits. It is particularly convenient to visit on your way to and from the technical exhibits. While in the Multimedia Education Center, you will be able to study the very latest in orthopaedic video education. Stop by the Center, located in the Sails Pavilion of the San Diego Convention Center to view this year's distinguished programs.

A choice of 30 stations

With 30 viewing stations, this year's Multimedia Education

Continued on page 34

Tendon repair strategy recieves Vaughan award ...

Continued from page 2

wanted to "determine in vivo forces and subfailure and failure properties of normal tendon tissue."

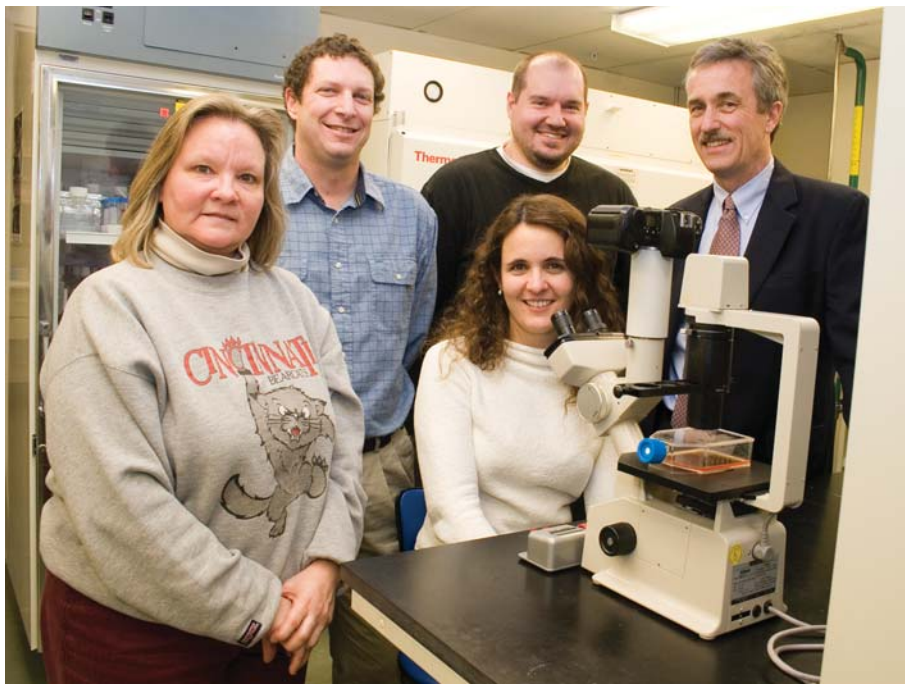
Applying FTE to tendons

To achieve this goal, the team recorded force patterns in two normal (rabbit) tendon models and then expressed these peak forces as percentages of failure force for selected activity levels. They then compared these peak forces to those for repairs of central defects in a rabbit patellar tendon model.

By lowering the MSC concentration of these cell-collagen gel constructs and replacing the suture with end-posts in culture, the team discovered that failure forces in the cell-treated 12-week repairs were greater than peak in vivo forces for all activities studied. The next evolution involved augmenting the collagen gel with a type I collagen sponge to increase repair stiffness and maximum force. This resulted in a repair whose tangent stiffness matched normal stiffness up to peak in vivo forces.

These studies demonstrated two important facts. First, adding a collagen sponge to a collagen gel containing a lower cell-to-collagen ratio dramatically improved the handling characteristics of the construct before surgery. Second, the repairs made with the cell-gel-sponge construct were better (both structurally and materially) than repairs made using simply a cell-gel construct. Moreover, mechanically stimulating these constructs in bioreactors further enhanced repair biomechanics compared to normal.

As their studies progress, the team says that it is "now optimizing components of these mechanical signals in culture to further improve construct and repair outcome. Their contributions in the area of tendon functional tissue engineering have the potential to create functional load-bearing repairs that will revolutionize surgical reconstruction after tendon and ligament injury."



(From left) Cynthia Gooch, BS; Gregory P. Boivin, DVM; Natalia Juncosa-Melvin, PhD; Jason T. Shearn, PhD; and David L. Butler, PhD have been awarded the 2007 Ann Doner Vaughan Award for their research and manuscript on "Functional Tissue Engineering for Tendon Repair: A Multidisciplinary Strategy Using Mesenchymal Stem Cells, Bioscaffolds and Mechanical Stimulation." (Not pictured: Marc T. Galloway, MD and Hani Awad, PhD.) Continuing the research they began in the 1970s, the team engaged in new studies to accelerate tendon repair by using high density cell-based constructs.

FTE potential

By using the benchmarking approach, the team hopes to produce continuous improvements in conventional repair measures. Their goal is to build on this and other innovations in improving repair performance in different tendon models, "to increase tangent stiffness of patellar tendon repairs to match normal patellar tendons up to 40 percent of failure by 12 weeks and to accelerate repair so 6-week repairs perform as well as current 12-week repairs."

The FTE approach, the team says, is also applicable to other musculoskeletal structures. They are currently identifying functional tissue engineering parameters (FTEPs) for tissues such as ligaments and menisci, which are of increasing structural and mechanical complexity. The team adds that "fundamental to all tissues is the need to measure their actual in vivo forces and displacements for relevant activities of daily living."

Interdisciplinary approach

The potential of a "truly 'functional' tissue engineering outcome," the writers add, depends on an interdisciplinary approach—more than a focus on mechanical and structural criteria. The researchers suggest that "cell, molecular and developmental biologists, for example, might categorize a successful outcome as one in which cell phenotype can be controlled and gene expression can be assessed in near real time to better mimic the function of the normal growing tissue."

To implement this interdisciplinary approach, the team has been collaborating with scientists in genetics and in cell-matrix interactions to monitor RNA expression of cells in their constructs and to create singly and doubly transgenic mice whose cells selectively fluoresce when certain collagen genes (I and II) are upregulated.

Such interdisciplinary studies are needed "to determine the extent to which tissue-engineered constructs express the correct genes and proteins and how mechanical stimuli delivered in culture might influence gene expression to ultimately guide tissue engineering experiments and spatially and temporarily control cell phenotype in a maturing construct," according to the authors.

The team's research was funded by grants from the National Institutes of Health given to the University of Cincinnati and to Osiris Therapeutics, by the Cincinnati Sports Medicine Research and Education Foundation, and by a Merit Review grant from the Veteran's Administration to Gregory Boivin, who also holds an appointment at Veterans Affairs Medical Center, Cincinnati. The research team plans to use the funds from the award for summer undergraduate and graduate research fellowships and for pilot research projects.

Kappa Delta, OREF winners ...

Continued from page 1

History of awards

During their Golden Anniversary commemoration in 1947, Kappa Delta Sorority established the annual Kappa Delta Research Fellowship in Orthopaedics. Over the years, the award has grown from one recipient paper and $1,000 stipend to three recipient papers, each receiving an award of $20,000. Since 1950, Kappa Delta has given nearly $1.1 million in support of orthopaedic research through these awards.

The OREF is the only independent, surgeon-driven organization supporting research in the musculoskeletal area. The Board of Trustees presented the first Clinical Research Award and accompanying $20,000 stipend in 1994. The award is given to encourage clinical research in orthopaedics.

FDA STATEMENT

Some drugs or medical devices demonstrated at the Annual Meeting have not been cleared by the FDA or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical devices he or she wishes to use in clinical practice.

Academy policy provides that "off label" uses of a drug or medical device may be described in the Academy's CME activities so long as the "off label" use of the drug or medical device is also specifically disclosed (i.e. it must be disclosed that the FDA has not cleared the drug or device for the described purpose). Any drug or medical device is being used "off label" if the described use is not set forth on the product's approval label.

OREF recognizes research on rotator cuff disease

By Sally Chapralis

The award-winning paper presents 20 years of research on rotator cuff disease by Dr. Gerber and his colleagues

Christian Gerber, MD, FRCSEd (hon), has received the 2007 Orthopaedic Research and Education Foundation (OREF) Clinical Research Award for his manuscript on "Rotator Cuff Disease: From Scientific Understanding to Patient Care." Dr. Gerber is a professor and chairman of the department of orthopaedic surgery at the University of Zurich, Switzerland, and an international member of the AAOS and the American Shoulder and Elbow Surgeons.

The award-winning paper presents 20 years of research on rotator cuff disease by Dr. Gerber and his colleagues. Their studies have examined the anatomic criteria predisposing to rotator cuff disease, the possibilities of diagnosis by clinical examination and imaging and the pathophysiology of muscular changes after rotator cuff tear and repair. The author has introduced these findings into the current clinical practice of management of rotator cuff surgery. These studies have directed research toward the entire muscle-tendon-bone unit, rather than to the tendon alone, and have led to new surgical procedures for treatment of rotator cuff tearing.

Dr. Gerber's research on rotator cuff disease encompasses several areas, including anatomic descriptions, clinical diagnosis, radiographic diagnosis, causes of rotator cuff repair failure from mechanical and biologic perspectives, clinical evaluations of rotator cuff repairs, and salvage surgeries for irreparable rotator cuff tears.

In the area of isolated subscapularis tendon tears, for example, Dr. Gerber not only described these injuries, but his contributions to the development of the "lift-off test" and the "belly press test" have allowed surgeons to reliably diagnose these tears and to have guidelines regarding their reparability and their repair.

His studies on the mechanical properties of sutures, tendon grasping techniques and anchoring the tendon to bone have resulted in new tendon-to-bone repair techniques. After being validated in both experimental animals and humans, these techniques have established the current standard of reference for rotator cuff repair.

To address tears beyond repair, Dr. Gerber's team introduced the concept of tendon transfers into shoulder surgery. He pioneered the latissimus dorsi tendon transfer as a salvage procedure for the treatment of irreparable posterosuperior tears.

Anatomic descriptions

Dr. Gerber's anatomic studies, delineated "the relationship between rotator cuff tears and glenoid orientation, but also between rotator cuff tear and lateral overhang of the acromion." Dr. Gerber's team "identified an association between rotator cuff tear and the orientation of the glenoid relative to the axis of the supraspinatus fossa and concluded that greater glenoid retroversion is predictive of an anterior cuff injury whereas greater anteversion is predictive of a posterior cuff injury and that rotator cuff tearing was associated with a wide lateral extension of the acrion."

Clinical diagnosis

The team's study of isolated tears of the tendon of the subscapularis muscle was the first to describe the lift-off test as a "reliable way to diagnose or exclude subscapularis insufficiency…as a source of a patient's pain." Dr. Gerber's study also concluded that "while other case reports noted an instability episode with a subsequent subscapularis tear, no patients in this series report instability but rather a forceful adduction or hyperextension of an adducted arm as the traumatic mechanism."

Dr. Gerber's research on rotator cuff disease encompasses several areas, including anatomic descriptions, clinical diagnosis, radiographic diagnosis, causes of rotator cuff repair failure from mechanical and biologic perspectives, clinical evaluations of rotator cuff repairs, and salvage surgeries for irreparable rotator cuff tears.

Another study focused on isolated ruptures of the subscapularis tendon. This study, the first to evaluate the clinical outcome of surgical repair, introduced the diagnostic belly-press test. A patient with a subscapularis insufficiency is unable to forcibly press his palm to his abdomen and keep his elbow anterior to his abdomen or to actively internally rotate his arm to maintain the press against his abdomen. This study also demonstrated that open subscapularis repair is an effective treatment for this condition.

Radiographic diagnosis

Three studies addressed the diagnostic effectiveness of magnetic resonance (MR) imaging techniques. MR arthrography was found to be accurate for detecting lesions of the subscapularis; MR spectroscopy was established as useful in quantifying fatty infiltration of rotator cuff musculature; and MR imaging after rotator repair almost always showed subacromial bursitis-like findings. Small retears or residual defects, however, were not necessarily associated with symptoms.

Mechanical causes for rotator cuff repair failure

Dr. Gerber's six studies in this area tested and improved potentially "weak mechanical links in the rotator cuff repair construction," ranging from "anchor pullout, anchor strength, effect of eyelet, strength and type of suture, to type of suture fixation of the tendon."

One study, for example, addressed the influence of test temperature and test speed on the mechanical strength of absorbable suture anchors. The results of this study showed that "testing implants at room temperature can falsely improve results by a factor of 50, and that it is mandatory to test absorbable implants at body temperature, preferably at slower speeds."

Biologic causes for rotator cuff repair failure

After reviewing problematic mechanical links in rotator cuff repair, the team looked at biologic sources of failure, such as osteopenia of the humeral head, the tissue ramifications of delayed cuff repair, the assessment of fatty infiltration, and the biomechanical manifestations of this infiltration.

Recognizing the importance of bone quality for the secure fixation of tendon to bone, Dr. Gerber examined the association of osteopenia of the humeral head with full-thickness rotator cuff tears. This study compared the bone density of cadaveric humeral heads with a full-thickness rotator cuff tear to those without a tear, using microcomputed tomography. Specimens with a tear had reduced cancellous bone and higher bone density under the articular surface compared to the greater tuberosity, leading to a recommendation that surgeons place sutures or anchors subcortically or under the articular surface.

Continued on page 33

OREF recognizes research on rotator cuff disease ...

Continued from page 32

Clinical evaluation of rotator cuff repairs

The first of Dr. Gerber's studies in this area evaluated the results of repair of massive tears of the rotator cuff. As he says, the purpose was "to apply the biomechanically superior techniques of rotator cuff repair, as determined in vitro in our previous studies, to patients and determine if they are efficacious in vivo."

The prospective study followed 29 patients with massive rotator cuff tears consisting of at least two tendons for a minimum of two years. All tears were repaired with number 3 braided nonabsorbable sutures with a modified Mason-Allen stitch, secured to the bone via transosseous passage of the sutures, which were then tied over a small augmentation plate.

After repair, patients experienced an improvement in forward flexion and average abduction, as well as a reduction in pain and an increase in the ability to participate in activities of daily living. Radiographs, however, demonstrated a retear rate of 34 percent, "considerably lower than the 50 percent to 70 percent failure rate reported in previous studies of repair with comparable tears." Patients who had a retear had improved from their preoperative condition but less so than those with a successful repair.

Another study evaluated patients' clinical outcome after structural failure of rotator cuff repairs. Of 20 patients with structural failures, 17 patients were either very satisfied or satisfied with their clinical results. If the goal of treatment is optimal function recover, writes Dr. Gerber, "MR imaging of repair failure and therefore potential rerupture should not be a contraindication to attempted repair."

The team's 2006 study of the structural changes in the musculotendinous units after open repair of a single tendon tear found that "while patients clinically had significant subjective and objective improvements, successful repair was not associated with a decrease in muscle atrophy and was associated with increased fatty infiltration of the muscle."

Salvage surgeries

Because "some massive tears are so large that they are not amenable to repair," Dr. Gerber writes, "we pioneered the latissimus dorsi tendon transfer as a salvage surgery for irreparable rotator cuff repairs." A preliminary report in 1988 had introduced the procedure, and a 1992 study established it—via surgical application to 16 patients who were followed for an average of 33 months—as an effective surgical approach to irreparable cuff tears.

The team concluded that "in cases with good subscapularis function but irreparable defects of the external rotator tendons, restoration of approximately 80 percent of normal shoulder function was obtained, indicating that latissimus dorsi transfer is a safe and valuable alternative for the treatment of massive posterosuperior rotator cuff tears."

Results of a 2006 study of 67 patients "with 69 irreparable tears of at least two tendons were treated with latissimus dorsi tendon transfer and followed for an average of 53 months" reconfirmed the efficacy of the surgery, provided the subscapularis is intact.

Dr. Gerber's team has also reviewed patient results for those receiving the Delta III inverse total shoulder arthroplasty to treat pseudoparalysis associated with irreparable rotator cuff dysfunction. The team followed 58 patients with the prostheses for an average of 38 months. They confirmed that the prosthesis had the potential to "improve the condition of patients with severe shoulder dysfunction, and that while complications were frequent with both primary and revision surgery, they rarely affected the final outcome."

Dr. Gerber's research has been supported by grants from the Swiss National Science Foundation, Vontobel Foundation, Resortho Foundation, Balgrist Foundation, and University of Zurich. He has no commercial interests in the results of his work and has not received money or anything of value from commercial sources.