Temporomandibular Joint Disorder

TMJ Bioengineering Conference

September 20-22, 2012 Pittsburgh, PA

University Club

At the University of Pittsburgh

123 University Place
Pittsburgh, PA 15260

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TMJ Bioengineering Conference - 3

Thursday, September 20 through Saturday, September 22, 2011
University Club
Pittsburgh, PA

Welcome!

It is indeed our pleasure to welcome you to Pittsburgh, PA, for the third Temporomandibular Joint Bioengineering Conference (TMJ3)!

Once again, we have reunited our friends and colleagues for another lively scientific discussion of state-of-the-art research on the TMJ. We are pleased that this meeting continues to be an attractive venue where students as well as junior and senior level biologists, engineers, and clinicians can get together to exchange ideas, learn from one another, develop friendship and establish collaboration.

Consistent with that theme, this year's program focuses on special topics with accompanying keynote speakers such as markers and cell based therapies, in vivo mechanics, pathophysiology of the TMJ, and bioscaffold based functional tissue engineering.

We would especially like to thank our generous sponsors, the program committee, and our local organizers, Diane Turner and Michele Leahy; all of your support is an integral part of maintaining the high quality of this meeting.

Please enjoy the conference!

With our very best wishes.

Sincerely,
Alejandro Almarza, PhD
Michael Detamore, PhD
Kyriacos Athanasiou, PhD, PE
Jeremy Mao, DDS, PhD
The TMJ3 Organizing Committee

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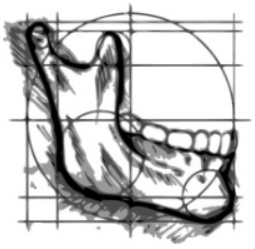

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General Information

Aims of the Symposium

The *TMJ Bioengineering Conference* provides a forum to discuss state-of-the-art TMJ research. By bringing together leaders as well as budding investigators in our field, we hope to address challenging problems in clinical management of TMDs, and set new directions in biomechanical and biological research that hold great potential for the future.

Organizing Committee

Alejandro Almarza – Chair
Michael Detamore
Kyriacos Athanasiou
Jeremy Mao

Program Committee

Kyle Allen
Mildred Embree
Sunil Wadwa
Alejandro Almarza

Instructions to Presenters

I. Podium Presenters

The time for presentations will be limited, in favor of more time for discussion. Therefore, the speakers and moderators have been asked to limit the number of slides as well as to adhere to the time allotted for each presentation.

Important Notes:

All speakers are asked to check-in with the projectionist and the session moderators 15 minutes before the start of session in which they will present.

For 15 minute time slots

10 min. presentations each immediately followed by a 5 min. discussion.
Maximum **10 PowerPoint slides** for computer presentation.

Note: In view of time and the large number of talks, there will be no opportunity to use your personal computer or load your PowerPoint file during the symposium.

II. Poster Presenters

All posters should be no larger than 45 inches x 45 inches (114.3 cm x 114.3 cm). Poster boards will be available in the Gold Room, adjacent to the meeting room (Grand Ballroom B). Please set up your poster between 7:30 - 8:00 am and leave the posters up throughout the day. Posters are to be taken down at the end the day on Friday.

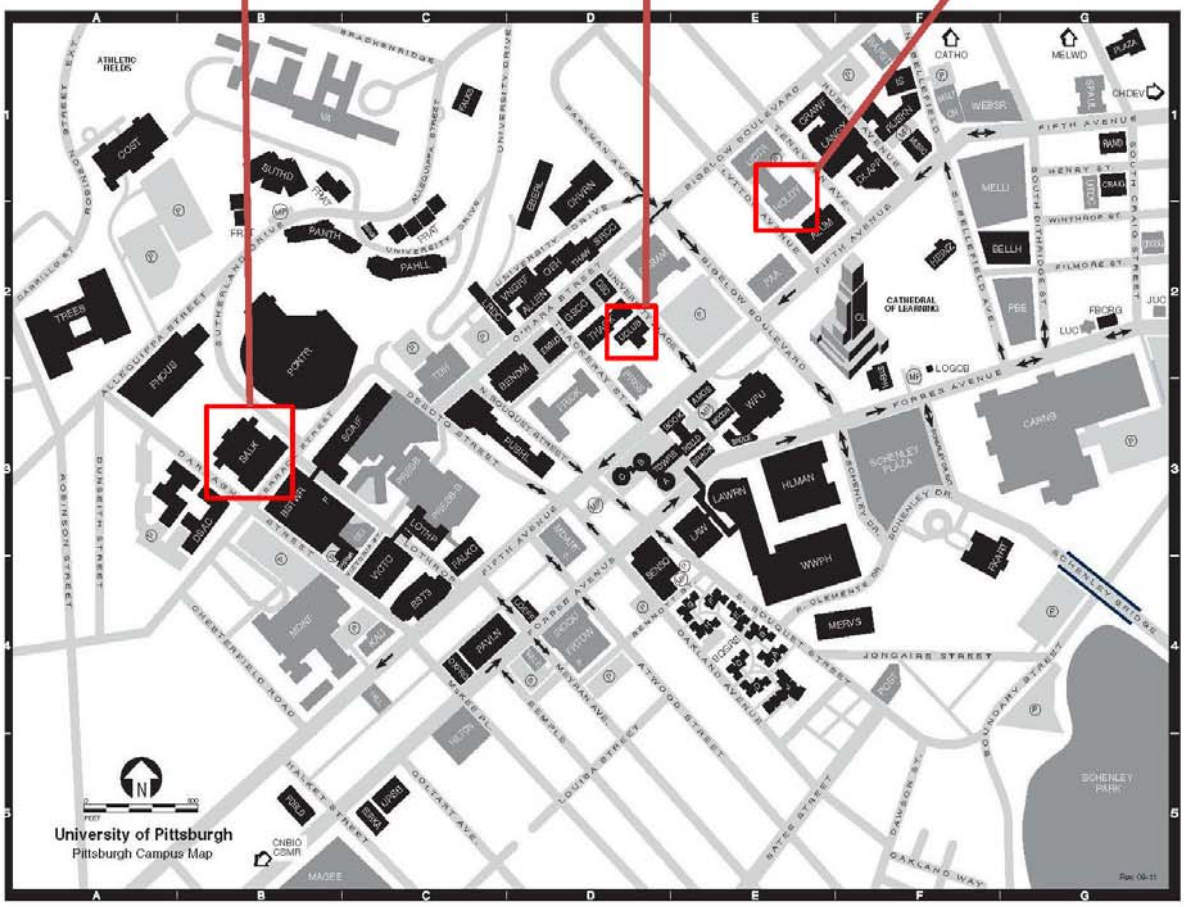
University of Pittsburgh

Pittsburgh Campus Map

School of Dental Medicine
3501 Terrace St.
Pittsburgh, PA 152161

University Club
123 University Place
Pittsburgh, PA 15260

Holiday Inn
University Center
100 Lytton Ave.
Pittsburgh, PA 15213



Featured Speakers

Keynote Speakers

Dr. Louis G. Mercuri, DDS, MS is a *Cum Laude* graduate of Georgetown University School of Dentistry, Washington, DC. He received his Certification and Master of Science degree in Oral and Maxillofacial Surgery from the University of Illinois Chicago. Dr. Mercuri was a full-time member of the Oral and Maxillofacial Surgery faculties at the University of Illinois Chicago College Of Dentistry and the Virginia Commonwealth University Medical College of Virginia School of Dentistry, Richmond, Virginia. He has been Chairman of the Department/Division of Oral and Maxillofacial Surgery at the Chicago Michael Reese Hospital and Medical Center, University of Illinois Chicago College of Dentistry and Loyola University Chicago Medical Center. He is presently the Clinical Consultant for *TMJ Concepts*, Ventura California. Dr. Mercuri is a Life Fellow of the American Association of Oral and Maxillofacial Surgeons and a Retired Diplomate of the American Board of Oral and Maxillofacial Surgeons. He is also a member and has held office in numerous other professional associations. Over his career, Dr. Mercuri has been the recipient of numerous research grants, published extensively and has been invited to lecture nationally and internationally on the diagnosis, non-surgical and surgical management of temporomandibular joint disorders. He is the recipient of the 2009 Oral and Maxillofacial Foundation Research Recognition Award, the 2010 William J. Gies Foundation Distinguished Achievement Award in Oral and Maxillofacial Surgery and has been awarded an Honorary Fellowship in Faculty of Dental Surgery from the Royal College of Surgeons of England for his body of work in the area of alloplastic temporomandibular joint replacement.

Marcus Teschke is the attending surgeon at the Department of Oral and Maxillofacial Plastic Surgery at the University of Bonn Germany. Born in Klotz Germany, Dr. Marcus Teschke attended the University of Bonn, Germany. Dr. Marcus Teschke clinical interests and research efforts have focused on TMJ surgery and TMJ tissue engineering in cooperation with Friedrich-Baur-Institute Bayreuth, Germany (cooperation partner: Daniel Seitz, Biologist, head of the Institute). Dr Marcus Teschke professional organizations include the European Society of Temporo-mandibular Joint Surgery, European Academy of Facial Plastic Surgery, Fellow of the European Board of Oro-Maxillofacial Surgery and the German Association of Oral and Cranio-Maxillofacial Surgery.

Dr. Mark Wong is a tenured Professor and Chairman of the Department of Oral and Maxillofacial Surgery at The University of Texas Dental Branch at Houston, where he also serves as the Director of Residency Training. He holds clinical appointments to Memorial Hermann Hospital, Ben Taub General Hospital, LBJ General Hospital and The Methodist Hospital. He also holds academic appointments with The University of Texas Graduate School of Biomedical Sciences at Houston and the Department of Bioengineering at Rice University.
Dr. Wong has actively served on a number of local and national committees and is currently Immediate Past-President of the American Board of Oral and Maxillofacial Surgery after serving many years as an examiner. His clinical interests and research efforts have focused on maxillofacial traumatology, facial reconstruction, tissue engineering of bone and the biomechanical characterization and regeneration of the temporomandibular joint. He has delivered numerous CE courses and lectures in these areas both nationally and internationally and authored textbook chapters and papers on these subjects. Current research in the field of regenerative medicine is supported through NIH funding and the Department of Defense's Armed Forces Institute of Regenerative Medicine.

Local Keynote Speakers

Johnny Huard, PhD, of the University of Pittsburgh is a professor in the Departments of Orthopaedic Surgery, Molecular Genetics, Biochemistry, Bioengineering, Pathology and also the director of the Stem Cell Research Center. He has been named the Henry J. Mankin Endowed Chair in Orthopaedic Surgery Research. Dr. Huard is also deputy director for cellular therapy at the McGowan Institute for Regenerative Medicine (MIRM) and an associate director of the Pittsburgh Tissue Engineering Initiative (PTEI). Dr. Huard is co-founder of Cook MyoSite, Inc., a biotechnology company. Dr. Huard's main research focus is to expand the possibilities of tissue engineering by unlocking the potential of gene therapy and adult stem cell research and transferring research findings into the development of effective treatments for damaged or diseased tissues as they relate to the musculoskeletal system. He has established international recognition for his research discoveries in this area and made significant preclinical advances in the isolation, identification and characterization of muscle-derived stem cells. He is currently using those findings to explore and develop cutting-edge treatment programs to address Duchenne muscular dystrophy (DMD) and a variety of orthopaedic diseases and injuries including muscle injuries and repair and regeneration of bone and articular cartilage. Dr. Huard's research program is funded by a variety of sources including the National Institutes of Health, the Muscular Dystrophy Association, as well as other private and public foundations. Dr. Huard has been recognized by University of Pittsburgh Chancellor Mark A. Nordenberg, as a recipient of the Chancellor's Distinguished Research Award. Other honors include the University of Quebec Prix D'Excellence in 2007.

Alejandro Almarza, PhD, is an assistant professor in Oral Biology in the School of Dental Medicine with a secondary appointment in Bioengineering. Dr. Almarza graduated with a PhD from Rice University after obtaining a BS in Chemical Engineering from Florida State University. He joined the faculty at the University of Pittsburgh in 2005. Dr. Almarza's research instest include biomechanics and tissue engineering. Understanding the normal biomechanical properties and joint mechanics/motion of the Temporomandibular Joint (TMJ) will be paramount for determining diseased states and to start elucidating the progress of Temporomandibular Joint Disorders (TMDs). Few studies have correlated the mechanical properties (under tension, compression, shear) of the different structures of the TMJ to each other, such as the bones of the mandibular condyle and glenoid fossa and their respective fibrocartilages, along with the TMJ fibrocartilaginous disc. This biomechanical knowledge would also allow for the creation of relevant finite element models to assess the contribution of the different structures. Further, whole diarthrodial joint mechanics/ motion need to be determined to assess the appropriateness of current reconstructive techniques. For Tissue Engineering Approaches for the Temporomandibular Joint, the goal of this research is to utilize novel tissue engineering techniques, such as ink jetting of nanostructured materials, gene delivery therapies, and stem cells application, for bone and fibrocartilage tissue engineering applications. Ink jetting will allow for reconstruction of the original 3D structure of the TMJ tissues, while controlling at the nanoscale the deposition of bioactive molecules and/or cells. Further, gene delivery will elicit the appropriate response from seeded or migrating cells to recapitulate the original tissues. Additionally, mesenchymal stem cells (MSCs) are capable of dividing and differentiating into bone, cartilage and fibrocartilage cells. These MSCs also secrete a variety of cytokines and growth factors, known as trophic factors, that suppress the local immune system, inhibit scar formation and apoptosis, enhance angiogenesis, and stimulate mitosis and differentiation of tissue-intrinsic reparative or stem cells.

Location: **University Club – Ballroom B**
123 University Place
Pittsburgh, PA 15260

7:30 am **Breakfast, Registration, Check-In**

8:30 am **Opening Ceremony, Welcome & Announcements**
Alejandro Almarza

Keynote Lecture:

8:45 am TMJ Replacement - Past, Present and Future Considerations
Louis Mercuri

9:45 am **Break**

Podium Session 1: **Implants and TMJ Modeling**
Session Chair: ***Marcus Teschke***

10:15 am Twenty Year Follow-up of Patient–fitted Total Joint Prosthesis for Reconstruction of the Temporomandibular Joint
Allen WR, ***Movahed R****, Wolford LM*

10:30 am Mandibular Kinematic and Maximum Voluntary Bite Force in Patients with Alloplastic Total TMJ Replacement – A Prospective Study
Linsen SS*, Reich RH, Teschke M*

10:45 am An Approach to Designing a Temporomandibular Joint prosthesis
Mesnard M*, Ramos A*

11:00 am Biomechanical Evaluation of Human Mandible: Cadaveric Experiments and Finite Element Analysis
Ingawale SM**,** *Krishnan D, Goswami T*

11:15 am 3D Finite Element Analysis of Temporomandibular Joint Prosthesis Replacement
Liu P-H, *Huang T-H*

11:30 am **Discussion Group**

12:00 pm **Lunch**
Poster Viewing

Keynote Lecture:

1:00 pm Challenges in TMJ-Surgery
Marcus Teschke

Podium Session 2: **Molecular Mediators in TMJ Pathogenesis**
Session Chair: ***David Rowe***

2:00 pm Estrogen Receptor Beta Deficiency Causes Increased Growth in the Mandibular Condyle
Wadhwa S*, Kamiya Y, Chen J, Xu M, Utreja A, Chae T*

2:15 pm Expression of ADAMTS-4 in Deformed Human Temporomandibular Joint Discs
***Matsumoto T**, Tojyo I, Kiga N, Fujita S*

2:30 pm Temporal-course of Heme-oxygenase-1, TNF-α and IL-1β gene Expression in the Trigeminal Ganglia of the Zymosan-induced Temporomandibular Joint Hypernociception
***Chaves HV,** Rocha do Val D, Ribeiro KA, Lemos JC; Rios LC; Fernandes-Araújo IW, Souza RB, Silva da Cunha RM, Barros Benevides NM, Alves Pereira KM, Rodrigues e Silva AA, Teixeira Pinto VP, Clemente-Napimoga JT, Bezerra MM, Brito GAC*

2:45 pm **Discussion Group**

Poster Session:

3:00 pm **Afternoon Break**

Podium Session 3: **Surgical Treatments**
Session Chair: ***Larry Wolford***

3:45 pm Masseter and Temporalis Excursive Hyperactivity Decreased by Measured Anterior Guidance Development
***Kerstein RB**, Radke J*

4:00 pm Condylar Reconstruction Using Hydroxyapatite/collagen Vs Sternoclavicular Graft
Mehrotra D

4:15 pm Use of Platelet Rich Plasma in TMD Therapy- Preliminary Study
***Machon VK**, Hirjak D*

4:30 pm Treatment of Condylar Hyperplasia with High Condylectomy, Articular Disc Repositioning and Concomitant Orthognathic Surgery
***Almeida LE**, Oliveira Filho MA, Doetzer A*

4:45 pm **Discussion Group**

5:15 pm **General Discussion**

Location: **University Club – Ballroom B**
123 University Place
Pittsburgh, PA 15260

7:30 am **Breakfast, Registration, Check-In**

Keynote Lecture:

8:30 am Challenges and Considerations in Tissue Engineering of the TMJ
Mark Wong

Podium Session 4: **Stem Cells Therapies and TMJ Development**
Session Chair**: *Mildred Embree***

9:30 am TMJ derived Stem Cells: Properties, Clonal Characteristics, and Regeneration Potential
Embree M*, Shakoori P, Castillo J, Vlahos M, Xin T, Eisig SB, Mao JJ*

9:45 am Producing a Spectrum of Fibrocartilages from Human Embryonic Stem Cells using a Chondrogenic Tuning Process
Willard VP*, Sanchez-Adams J, Lee JK, Athanasiou KA*

10:00 am RNA Expression Profiles of Cells within the Lineage that Forms the TMJ
Yadav S, Glynn J, Joshi P, Shin D-K, ***Rowe DW***

10:15 am GFP Reporters for Assessing Lineage Progression in the Condylar Cartilage
Yadav S*, Utreja A, Jiang X, Huang J, Maye P, Kalajzic I, Rowe DW*

10:30 am **Discussion Group**

10:45 am **Break**

Local Invited Speaker:

11:00 am Exhaustion of Progenitor/Stem Cells During Aging and Disease: Implication for Stem Cell Therapy
Johnny Huard

Podium Session 5: **Animal Models of TMD**
Session Chair: ***Kyle Allen***

11:30 am Large Animal Study of TMJ Condyle Reconstruction using Living Tissue-engineered Bone Grafts
Bhumiratana S*, Alfi DM, Yeager K, Bernhard JC, Eton RE, Bova J, Shah F, Gimble JM, Lopez MJ, Eisig SB, Vunjak-Novakovic*

11:45 am Temporomandibular Joint Disorders in Dogs and Cats: A Computed Tomographic Study (2006-2011)
Arzi B*, Cissell DD, Verstraete FJM, Kass PH, DuRaine GD, Athanasiou KA*

12:00 pm Behavioral Assays of Orofacial Pain for the Rat Preclinical Model of TMJ Dysfunction
Pettengill T*, Jenkins AC, Caudle RM, Neubert JK, Allen KD*

12:15 pm **Discussion Group**

12:30 pm **Lunch**
Poster Viewing

Local Invited Speaker:

2:00 pm Degeneration and Regeneration of the TMJ
Alejandro Almarza

Podium Session 6: **TMJ Tissue Engineering**
Session Chair: ***Alejandro Almarza***

2:30 pm Tissue Metabolism and Cell Development in TMJ-Disc Grafts
Seitz D*, Teschke M, Schuster S*

2:45 pm A Scaffold Based Approach to Reconstruction of the TMJ Meniscus
Brown BN*, Chung WL, Almarza AJ, Badylak SF*

3:00 pm Nanoenhanced Hydrogels for TMJ Repair & Regeneration
Karnik SJ*, Mills DK*

3:15 pm Development of a Laser Micro-Patterned Xenogenic Fibrocartilage Scaffold for the purpose of Temporomandibular Disc Tissue Engineering
Juran CM*, McFetridge PS*

3:30 pm **Discussion Group**

Poster Session

3:45 pm **Afternoon Break**

Podium Session 7: **Surgical Approaches for TMD (Part 1)**
Session Chair**: *Mark Wong***

4:30 pm Study of Local and Systemic Changes in Individuals with Temporomandibular Dysfunction
Uekama IC*, Regalo SCH, Semprini M, Siessere S, Bataglion C*

4:45 pm Alloplastic TMJ Implants for Correction of Severe Facial Asymmetry
Quinn PD*, Granquist E*

5:00 pm **Discussion Group**

5:30 pm **General Discussion**

7:00 pm **Dinner**

Location: **University Club – Ballroom B**
123 University Place
Pittsburgh, PA 15260

8:30 am **Breakfast**

Podium Session 8: **TMJ Biomechanics**
Session Chair: ***Luigi Gallo***

9:00 am Musculoskeletal Modeling of the Mandible Movement and Muscle Forces using the Opensim Software
Cadova M

9:15 am Friction Coefficients and Lubrication Mechanism of TMJ Disc and Condylar Cartilage
Zimmerman B, Bonnevie ED, Wang Liyun, Burris DL, ***Lu XL***

9:30 am Effect of Occlusal Splints on Nocturnal Masseter Behavior
Moser H, Vlcek D, Erni S, Cadova M, Ettlin D, ***Gallo LM***

9:45 am Viscoelastic Dynamic Characterization of the Porcine Temporomandibular Joint Disc under Compression
Fernandez P*, Lamela MJ, Ramos A, Fernandez-Canteli A, Tanaka E*

10:00 am **Discussion Group**

10:30 pm **Break**

Podium Session 9: **Surgical Approaches for TMD (Part 2)**
Session Chair**: *Lucas Lu***

10:45 am The whole body balance and TMJ. Correlation between TMD, cervical spine pain and headaches
Walczynska-Dragon K*, Baron S*

11:00 am Multidisciplinary Approach in the Management of Absolute Trismus with Bilateral Temporomandibular Joint Replacements for a Patient with Juvenile Rheumatoid Arthritis
Matthews NS

11:15 am MRI and sEMG of Masticatory Muscles in TMD Patients
Tartaglia GM*, Lodetti G, Felicio CM, Sforza C*

11:30 am Observations of Various Muscle Bundles Attaching to the Disc of the Temporomandibular Joint and the Condylar Process of the Mandible
Akita K*, Matsunaga K, Yamaguchi K*

11:45 pm **Final Discussion**

Location: **University Club - Gold Room**
123 University Place
Pittsburgh, PA 15260

Thursday, September 20, 2012 (3:00 PM) and Friday, September 21, 2012 (3:45 PM)

An anatomic study of the insertions of the lateral pterygoid muscle
***Sakaguchi T**, Fujishiro H, Shimazaki K, Ono T, Akita K*

A rat model of TMJ osteoarthritis using intra-articular injection of monoiodoacetate
***Rohrs EL**, Allen KD*

Repositioning Surgery of Temporomandibular Joint Disc using a 6 mm Titanium Screw and 0 - Coated Polyester Suture
***Almeida LE**, Oliveira MA, Doetzer A*

Costochondral Cells in TMJ Cartilage Self-Assembly
***Murphy MK**, Hu JC, Athanasiou KA*

Reconstruction of Ramus-condyle Unit with Transport Distraction Osteogenesis: A Report of Eight Cases and Review of Literature
***Chellappa AAL**, Mehrotra D, Mohammad S*

Biomechanics of Reconstructed condyles in TMJ ankylosis cases
***Gupta C**, Mehrotra D, Mohammad S, Singh RK*

Development of Superselective TMJ Arthroscopic Surgery: The Combination of TMJ Arthroscopic Surgery using Double Puncture Technique and Histopathology Information of Surgical Specimen
***Fujita S**, Tojyo I, Kiga N, Matsumoto T*

Presurgical Arthroscopy in Surgical Treatment of Diacapitular Fractures ***Hirjak D**, Machon V*

Expression of Chondrogenetic Factors in Synovial Chondromatosis of the Temporomandibular Joint
***Tojyo I**, Shinohara Y, Matsumoto T, Kiga N, Fujita S*

Osteochondroma of the Mandibular Condyle: Reconstruction with Low Condylectomy and Orthognathic Surgery
***Wolford LM**, Dhameja A, Allen WR*

Poly (Glycerol Sebacate): A Novel Scaffold Material for Temporomandibular Joint Disc Engineering
***Hagandora CK**, Wang Y, Almarza AJ*

Micro-CT Analysis of Magnesium Screw Degradation in a Rabbit Model
***Henderson SE**, Chung WL, Chou DT, Kumta PN, Almarza AJ*

GFP reporters in the TMJ condylar cartilage and the response to mechanical loading
***Utreja A**, Jiang X, Nanda R, Rowe DW*

ABSTRACTS

0111 Twenty Year Follow-Up Of Patient–Fitted Total Joint Prosthesis For Reconstruction Of The Temporomandibular Joint

Allen WR, Wolford LM.
Dept of Oral and Maxillofacial Surgery, Baylor University Medical Center, Baylor College of Dentistry, Texas A & M University System, Dallas, TX, USA

Purpose: Techmedica total joint prostheses have been shown to be effective for total joint replacement. Previous studies have shown this prosthesis to be safe and effective at ten and fourteen year follow-up. The purpose of this study was to assess the safety and effectiveness of patient fitted TMJ total joint reconstruction system formerly Techmedica, Inc. (Camarillo, CA) now TMJ Concepts (Ventura, CA) after twenty year follow up. *Materials and Methods:* In a single private practice, fifty six patients who underwent TMJ joint replacement surgery between 1989 and 1993 were contacted by telephone or mail. Pre and post operative evaluations for eleven patients were compared with regard to facial pain, TMJ pain, jaw function, diet, and overall quality of life. *Results:* The subjective results for eleven patients comprised of 10 women and 1 man with an average age of 61.2 years were compared pre and post operatively using paired t-test. There was a statistically significant improvement in facial pain (p=0.0097), TMJ pain (p=0.0122), and diet (p=0.0068). Ninety percent of patients surveyed reported an overall improvement in quality of life after surgery. *Conclusions:* These data support the use of patient-fitted total joint prostheses for reconstruction of the TMJ joint in the patient population surveyed. Patients showed an improvement in pain, diet, and overall quality of life from surgery after a 19.1 year follow-up.

NOTES:

0112 Mandibular Kinematic And Maximum Voluntary Bite Force In Patients With Alloplastic Total TMJ Replacement – A Prospective Study

Linsen SS, Reich RH, Teschke M
Department of Prosthodontics, Preclinical Education and Dental Materials Science, and Department of Oral- and Maxillofacial Plastic Surgery, University Hospital Bonn, Germany

Purpose: The purpose was to analyze the mandibular patterns and the maximum voluntary bite force in patients with alloplastic total joint replacement (TJR). *Materials and Methods:* From May 2007 through February seventeen patients with different diagnoses resulting in condylar hypomobility (8 patients; 15 joints) and condylar instability (9 patients; 12 joints) had undergone alloplastic TJR. Kinematic (ultrasound-based jaw-tracking) and maximum voluntary bite force (custom made bite fork) data were recorded preoperatively (T0), 2 (T1), 6 (T2), and 12 (T3) months postoperatively. *Results:* Kinematic data revealed in patients with condylar hypomobility a statistically significant increase in all measured data except Incisal Range of Motion lateral excursion. In patients with condylar instability the results showed a statistically significant decrease for Incisal Range of Motion protrusion and laterotrusion and slight increase for Condylar Range of Motion, Incisal Range of Motion linear distance and opening and closing velocity. A significant effect of time was found for maximum voluntary bite force (increase; P<.001). *Conclusion:* Alloplastic TJR results in improved function in patients with joint hypomobility and in a decrease of abnormal hypermobility in patients with condylar instability. Biomechanical integrity of the stomatognathic system and the ability of the patient to triturate food can be improved.

NOTES:

0113 An Approach To Designing A Temporomandibular Joint Prosthesis

Mesnard M[1], Ramos A[2]
[1] Université de Bordeaux, Institut de Mécanique et d'Ingénierie, CNRS UMR 5295, Bordeaux, France ; [2] University of Aveiro, Biomechanics Research Group, Department of Mechanical Engineering, Aveiro, Portugal

The primary objective when designing an innovative medical device (MD) is to improve the patient's condition and autonomy. Normally, therefore, there must be a strong focus on continuous interaction with the human element. Despite this interaction, however, value analysis (VA) tools are in fact used very little at the design stage. Here, we describe the procedure we have devised and the characterization studies that result when applying VA to the design of a radically innovative temporomandibular joint (TMJ) prosthesis. From needs analysis to general availability of the device, there are three main phases in developing an MD: design, clinical validation and production/marketing. In the design phase, functional and technical specifications are defined from which numerical and/or physical prototypes are created. Our multidisciplinary team defined and prioritized service functions after first analyzing clinical need. Next it specified the performances of a healthy TMJ which had to be reproduced, and then devised the experimental methods to achieve this characterization. A finite element model (FEM) of the jaw was created and validated. Using simulations, the FEM compared deformations in the healthy and implanted mandibles. We then considered the influence of geometry, the links between implant/bone tissue to guide our decisions when creating innovative technical solutions.

NOTES:

0114 Biomechanical Evaluation Of Human Mandible: Cadaveric Experiments And Finite Element Analysis

Ingawalé SM[1], Krishnan D[2], Goswami T[1, 3]
[1]Biomedical, Industrial and Human Factors Engineering, Wright State University, Dayton, OH 45435; [2]Oral & Maxillofacial Surgery, University of Cincinnati Medical Center, Cincinnati, OH 45267; [3]Orthopaedic Surgery and Sports Medicine, Wright State University, Dayton, OH 45435

Analysis of biomechanical behavior of the temporomandibular joint (TMJ) components aids better understanding of structure, function, dysfunction, and necessary treatment options. We conducted a combined experimental-numerical study to explore strain, stiffness, and damage accumulation in mandibular bone. Sixteen fresh-frozen mandibles were harvested from donated human cadavers, and grouped four ways to undergo different cyclic loading configurations. The mandibles were tested to simulate 60,000 biting cycles, and then loaded to failure. Damage, defined in terms of the inverse of stiffness, was used to represent specimen behavior. A mathematical damage prediction model was developed using the Michaelis-Menten equation. The predicted damage was compared with experimental findings. In all groups, the majority of damage accumulation was observed during first few hundreds of cycles. Strain gauges were employed to continuously measure strain at select locations on the bone surface. 3-D finite element (FE) models constructed from computed tomography (CT) scans of the specimens were used to perform computer simulations paralleling the experimental testing. The FE-predicted strains were validated by comparing with the strain gauge data. The validated FE models are currently used to design and analyze patient-specific TMJ devices.

NOTES:

0115 3D Finite Element Analysis Of Temporomandibular Joint Prosthesis Replacement

Liu P, Huang T
Dept of Biomedical Engineering, I-Shou University, Kaohsiung, Taiwan

The purpose of this study was to investigate the stress concentration effect of screw number and insertion on mandible, condylar prosthesis component, and fixed screws with six types of screw distributions for prosthetic temporomandibular joint (TMJ) replacement. A 3D finite element (FE) model was consisted of a defected mandible of condylar resection (including cortical and concellous bone), the condylar prosthetic component and osteosynthesis screws. The seven mandibular muscles were applied as loading conditions to simulate the jaw closing, and boundary conditions were fixed at condylar head and central incisor. The FEA result showed that the least intensity of peak Von Mises stress of the mandible among the FE models was detected at the widespread screw distribution of the FE model. The dispersed screw insertion for the TMJ prosthesis replacement seems to decrease the effects of stress intensity and stress concentration. Moreover, the contact area increasing between the TMJ prosthesis and mandible may improve the stress concentration by dispersed screw insertion. Therefore, this study concluded that a wider screw distribution in the TMJ surgery seems to provide a better biomechanical stability and stress concentration decreasing to avoid screw fracture and loosening in the reconstructed mandible.

NOTES:

0121 Estrogen Receptor Beta Deficiency Causes Increased Growth In The Mandibular Condyle.

Wadhwa S, Kamiya Y, Chen j, Xu M, Utreja A, Chae T
Columbia University

Temporomandibular joint (TMJ) disorders predominantly afflict women of childbearing ages, suggesting a role of female hormones in the disease process. In long bones, estrogen via estrogen receptor beta (ER□) inhibits axial skeletal growth in female mice. We hypothesize that a similar mechanism is occurring in the mandibular condyle. 7, 49 and 120 day-old female WT and ER□ deficient mice were used in this study. The mandibular condylar cartilage was evaluated by histology and the subchondral bone was evaluated by micro-CT analysis. Gene expression from both was evaluated by real time PCR analysis. In the mandibular condylar cartilage, there was a significant increase in mandibular condylar cartilage thickness in the 49 and 120 day-old female ER□ KO compared to WT controls. Gene expression in 49 day-old female ER□ deficient mice revealed a significant increase in Collagen type X, PthrP and OPG expression and a significant decrease in Rankl and Ihh expression compared to WT controls. Subchondral bone analysis revealed a significant increase in total condylar volume and a decrease in the number of osteoclasts in 49 day-old ER□ KO compared to WT mice. There was no difference in proliferation between the genotypes. However, there were decreased expression of the cell cycle regulators, Tieg1 and p57, in the ER□ KO compared to WT mice. ER□ deficiency causes increased condylar growth in female mice by causing decreased resorption and decreasing the number of cells exiting the proliferative pool.

NOTES:

0122 Expression Of ADAMTS-4 In Deformed Human Temporomandibular Joint Discs.

Matsumoto T, Tojyo I, Kiga N, Fujita S
Department of Oral and Maxillofacial Surgery, Wakayama Medical University

Objective: Extracellular matrix (ECM) is important of physiological phenomenon such as generation and differentiation, progression of pathological condition (e.c. inflammation, tumor), and scaffold such as healing and regeneration. In TMJ disorders (TMDs), it has been suggested that pathological changes have a potential in collagen and the proteoglycan constituted ECM. It has been confirmed that a disintegrin and metalloproteinase with thrombospondin motifs (ADAMTS) is the aggrecanase which cleaves aggrecan at the Glu373-Ala374 site. ADAMTS is a family of extracellular metalloproteinases. They have a disintegrin-like domain and a metalloproteinase domain with several thrombospondin type I motifs. It has been reported that ADAMTS-4 and ADAMTS-5 are able to break down aggrecan. To study the expression of ADAMTS-4 in tissue samples of deformed human TMJ discs. **Result:** The discs extracted from cases with ID and OA presented positive reactions for ADAMTS-4.

NOTES:

0123 Temporal-Course Of Heme-Oxygenase-1, TNF-A And IL-1β Gene Expression In The Trigeminal Ganglia Of The Zymosan-Induced Temporomandibular Joint Hypernociception.

Chaves HV, Rocha do Val D, Ribeiro KA, Lemos JC, Rios LC, Fernandes-Araújo IW, Souza RB, Suilva da Cunha RM, Barros Benevides NM, Alves Pereira KM, Rodrigues e Silva AA, Teixeira Pinto VP, Clemente-Napimoga JT, Bezerra MM, Brito GAC
Universidade Federal do Ceará - Campus Sobral (Federal University of Ceará- Campus Sobral)

Heme-oxygenase-1(HO-1) is induced by cytokines, nitric oxide and other mediators during inflammatory responses. The purpose is to investigate the temporal-course of HO-1, TNF-α and IL-1β expression in trigeminal ganglia in zymosan-induced temporomandibular joint (TMJ) hypernociception. Male Wistar rats (200-220g)(n=6/gp) were anesthetized with tribromoethanol(1mL/100g,i.p.), received an intra-articular injection of zymosan(2mg/40μL) or saline(sham) into the left TMJ. At the 3h, 6h, 9h, 12h and 24h after TMJ arthritis, the facial hypernociception threshold was evaluated by electronic Von Frey, and the rats were euthanized to excise the trigeminal ganglia to perform the extraction of RNA and the immunohistochemistry. The RNA was obtained by TRIzol® reagent. cDNA was synthesized by the superscript® reverse transcript. mRNA expression were analyzed by qRT-PCR and normalized with GAPDH(housekeeping). Zymosan-induced TMJ arthritis caused significant time-dependent increased facial hypernociception started at the 3-hour until the 24h. qRT-PCR analysis showed a significant increasing in HO-1, TNF-α and IL-1β expression started at the 6h until the 24h in trigeminal ganglia in rats with TMJ arthritis. Immunohistochemical analysis showed an increased HO-1, TNF-α and IL-1β expression in the afferent neuron and in satellite glial cells in arthritic TMJ. These results suggest the HO-1, TNF-α and IL-1β participation in the patophysiological mechanisms of facial hypernociception.

NOTES:

0131 Masseter and temporalis excursive hyperactivity decreased by measured anterior guidance development

Kerstein RB, Radke J
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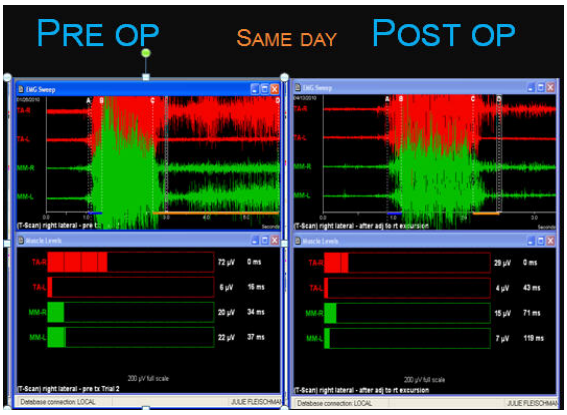

Purpose – To determine if statistically significant reductions in muscle activity ($p < 0.05$) occurs when prolonged Disclusion Time (> 0.4 sec/excursion) is shortened to < 0.4 sec/excursion with the Immediate Complete Anterior Guidance Development (ICAGD) enameloplasty. **Methods** – 45 symptomatic subjects had their right and left Disclusion Times recorded with the T-Scan III while simultaneously their bilateral masetter and anterior temporalis muscles were recorded electromyographically with BioEMG III (n = 180 muscles). Recording was done pre treatment and post treatment (same day) after undergoing the ICAGD enameloplasty without changing electrodes. The Student's t-test detected significant changes in thepre and post treatment lateral excursive muscle activity levels. **esults** – Highly significant reductions were found in all 4 muscles' after shortening the pretreatment prolonged Disclusion Time to < 0.4 seconds ($p < 0.0014$); after Bonferroni correction ($p < 0.006$). **Conclusion** – When properly performed, the ICAGD enameloplasty predictably reduces excursive muscle activity levels in the bilateral anterior temporalis and masetter muscles. **Clinical Implication** – Excursive muscle hyperactivity is a source of lactic acid accumulation, muscular ischemia, and chronic myalgic TMD symptoms. The ICAGD enameloplasty significantly reduces excursive muscle contractions after completion of the first ICAGD treatment. Typical same day of treatment excursive muscle activity change from the ICAGD enameloplasty.

NOTES:

0132 Condylar reconstruction using hydroxyapatite/collagen Vs sternoclavicular graft

Mehrotra D
CSM Medical University, Lucknow

Purpose: The aim of this study was to compare the results for condylar reconstruction using preshaped hydroxyapatite/collagen condyles soaked in platelet-rich plasma or sternoclavicular graft in patients with temporomandibular joint (TMJ) ankylosis. **Methods and Materials:** 23 patients with TMJ ankylosis in the age group of 4-16 years were included in the study, and randomly allocated to two surgical groups. Experimental group comprised of 12 patients where condyle was reconstructed using preshaped hydroxyapatite/collagen condyles soaked in platelet-rich plasma and control group had 11 patients where reconstruction was done with sternoclavicular graft. All patients were followed up for a minimum period of 12 months and functional /radiographic assessment were made to infer the treatment outcomes. **Results:** In experimental group radiographic evaluation at 3 months showed a less opaque condyle, but the opacity at 18 months was more defined, suggesting bone formation and ossification. In control group too there was maintenance of function, and radiographic evidence of a good condyle. **Conclusion:** The preshaped hydroxyapatite/collagen condyle with platelet-rich plasma is a promising alternative to sternoclavicular graft with reduced donor site morbidity. A long term study, to analyze the growth potential of the two condyles, should be planned.

NOTES:

0133 Use of platelet rich plasma in TMD therapy- preliminary study

Machon V, Hirjak D

Use of platelet rich plasma (PRP) is a new posibility in therapy of the arthritis of the temporomandibular joint. Our study compared 3 groups (A,B,C) of patients after conservative and miniinvasive therapy (arthrocentesis, arthroscopy) without decrease of pain. All patients in this groups are patients with retrodiscitis and synovitis (without general disease, without septic or autoimunitive arthritis). We included patients with symptoms in one temporomandibular joint (TMJ) only. Patients in group A (10 patients) underwent 2 intraarticulary aplication of corticoids, patients in group B (10 patients) underwent 2 intraarticulary aplication of autologous platelet rich plasma (1,5 ml) and patients in group C underwent rest therapy only (soft diet). This 3 months long-term study shows that intraarticulary aplication of autologous platelet rich plasma is an effective treatment method for patients with arthritis of the TMJ (70% of patiens with decrease of pain -an average pain score before aplication was 7, three months after PRP aplications was pain score 3,5).

NOTES:

0134 Efficacy of injecting Botulinum Toxin-A into the Lateral Pterygoid for the treatment of Anterior Disc Displacement with reduction.

Anand S, Matsa S
SRM Dental College, India

This study examined the effect of injection of botulinum toxin-A into the lateral pterygoid for the treatment of anterior disk displacement with reduction. The theory of internal derangement of the TMJ involves the anterior (and medial) displacement of the meniscus, which is thought to be brought about by the action of the upper head of the lateral pterygoid muscle. We have case reports of 10 patients who reported to the dental OP with severe pain and dysfunction of the temperomandibular joints. BTX-A block of the LP (25 U) was given twice under EMG guidance with 6-month interval). This temporarily reduced the action of the muscle, and the pain and dysfunction during that time interval was abolished. The pain and dysfunction did not recur in the observation period of 1 year.

NOTES:

0135 Repositioning Surgery of Temporomandibular Joint Disc using a 6 mm Titanium Screw and 0 - Coated Polyester Suture

Almeida LE, Filho OMA, Doetzer A
Hospital Univesitario Evangelico de Curitiba

Temporomandibular Joint Dysfunction (TMD) is a collective term used to describe a wide-range conditions affecting masticatory muscles, intraarticular and associated structures. The most common subtype of intraarticular dysfunction is the anterior articular disc displacement (with or without reduction) and when conservative treatments fails in improve signs and symptoms of this subtype of TMD, emerges a role of the surgical approach of temporomandibular joint. This report describes a repositioning surgery technique of temporomandibular joint disc by using a 6 mm titanium screw and 0 – coated polyester suture (Ethicon, Inc) attached to it. This is an economic alternative when comparing with classic methods of disc suturing using anchors and the results are very similar.

NOTES:

0211 *TMJ derived Stem Cells: Properties, Clonal Characteristics, and Regeneration Potential*

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Center for Craniofacial Regeneration, Columbia University Medical Center and Division of Oral & Maxillofacial Surgery, Columbia University College of Dental Medicine, New York, NY

Objectives: Whether the TMJ harbors stem cells is unknown. Our objectives were to identify putative TMJ stem cells and determine their regeneration potential. **Methods:** TMJ disc cells (DCs) and mandible condyle cells (MCCs) were isolated from rat and human TMJs and compared to donor-matched mesenchymal stem cells (MSCs). Cells were characterized using RT-PCR, immunocytochemistry, colony forming assay, flow cytometry and examined for multipotency. In total 64 clonal progenies were individually characterized. To test regenerative ability, DCs were seeded onto collagen sponge, transplanted on dorsum of nude mice for 8 weeks, and analyzed by histology. In parallel, a surgical TMJ regeneration model was created in rabbits and the condyle was replaced with an anatomically correct PCL scaffold. **Results:** Both DCs and MCCs had different gene and molecular profiles than MSCs. Heterogeneous DCs and MCCs and single cell clones underwent osteogenesis, adipogenesis, and chondrogenesis. DCs and MCCs formed single-cell colonies, with characteristic morphology, size and protein expression. Transplanted DCs formed ectopic cartilage tissue. Post-operative surgical placement of anatomically correct TMJ scaffolds in rabbits was stable after 8 weeks. **Conclusion:** The TMJ harbors stem-like cells that may participate in tissue homeostasis and may be used for regenerative TMJ therapies.

NOTES:

0212 Producing a Spectrum of Fibrocartilages from Human Embryonic Stem Cells using a Chondrogenic Tuning Process

Willard VP, Sanchez-Adams J, Lee JK, Athanasiou KA

Fibrocartilages such as the temporomandibular joint (TMJ) disc and knee meniscus are prone to injury and have an inherent inability to self-repair. Harnessing the pluripotent nature of human embryonic stem cells (hESCs) may provide a solution. This study investigated a chondrogenic tuning method to expand cells from chondrogenically differentiated H9 embryoid bodies (EBs) toward the production of a spectrum of fibrocartilages. Following EB differentiation, cells were dissociated and self-assembled into constructs (P0 cells), or were chondrogenically tuned by passaging up to 5 times (P1-P5 cells) in a chondrocyte specific medium prior to self-assembly. Flow cytometry and qRT-PCR of cells prior to self-assembly revealed an overall increase in mesenchymal phenotype with passage, and constructs formed at each passage displayed distinct biochemical properties after 4 weeks of culture. P1 and P5 cells formed constructs with abundant collagen, but low collagen II:collagen I (Col2:Col1) ratio, similar to the TMJ disc periphery or the outer meniscus. P3 and P4 cells formed constructs with a high Col2:Col1 ratio and more glycosaminoglycans, mimicking the inner meniscus or the TMJ disc's intermediate zone. Thus, chondrogenic tuning was found to be a simple method of obtaining abundant cells that can produce a variety of fibrocartilages from differentiated hESCs.

NOTES:

0213 RNA expression profiles of cells within the lineage that forms the TMJ

Yadav S, Glynn J, Joshi P, Shin D-K, **Rowe DW**

The TMJ is a regenerating structure that arises from periosteal progenitor cells. We are developing tools to understand the molecular events controlling this regenerative process. Using GFP reporter mice, we are characterizing the progression of the earliest recognized multipotential progenitor (SMAA) as it bifurcates away from the osseous lineage to the fibrocartilage lineage with the onset of Dkk3 expression. The TMJ nicely displays this lineage order by the presence of SMAA->Dkk3 on the superficial level of the cartilage and subsequent progression to Tnc, Col3.6, Col2A1 and ColX in cells at progressively deeper levels of the structure. The reporters are being utilized to develop a RNA expression profile of the cells as they achieve increasing levels of differentiation. Dissected TMJ cartilage from 3 week old reporter mice are disrupted with collagenase digestion, and the cells are separated into distinct GFP population by FAC sorting. RNA extracted from each population has been subjected to microarray expression using the Illumina Beadstation. To date the analysis has been completed on the Dkk3 and Tnc sorted population, with Col3.6, Col2A1 and ColX soon to follow. The analysis provides a glimpse of how the different cell types contribute to the composite biology of the tissue especially as it relates to the control of wnt activity and vascularity.

NOTES:

0214 GFP reporters for assessing lineage progression in the condylar cartilage

Yadav S, Utreja A, Jiang X, Huang J, Maye P, Kalajzic I, **Rowe D**
University of Connecticut Health Center

Assessing the cellular heterogeneity associated with a regenerating structure is essential for mapping molecular basis for lineage control during growth and in response to injury. We are utilizing GFP reporters that are active in different types of cartilaginous tissues (fibrocartilage, articular cartilage and growth plate cartilage). While Col2A1 and Col10A1 reporters show activity in the expected cellular locations in the three tissue types, other reporters appear to have unique patterns of expression. A Dkk3-GFP reporter was active in the superficial pre-chondrocytic articular cells of fibrocartilage (temporo-mandibular joint, TMJ) and articular cartilage. Also common to both tissues are the synovial lining cells that express lubricin GFP, while deeper cells within the cartilage matrix are tenascin C GFP positive. Condylar cartilage shows reporter expression of osterix, BSP and Col1A1 after Dkk3 activation and prior to the onset of Col2A1 expression. Most striking is the activity of a SMAA-CreERT2 driver, which demonstrates that cells within the fibrocartilage develop from a SMAA progenitor, a lineage that is not observed in articular or growth plate chondrocytes. As more molecular and cellular detail is assembled to validate the meaning of these reporters within the context of cartilage biology, a better understanding of the signals that control lineage progression will emerge.

NOTES:

0221 Large animal study of TMJ condyle reconstruction using living tissue-engineered bone grafts

Bhumiratana S[a]; Alfi DM[b]; Yeager K[a]; Bernhard JC[a]; Eton RE[a]; Bova J[d]; Shah F[c]; Gimble JM[c]; Lopez MJ[d]; Eisig SB[b]; and Gordana Vunjak-Novakovic[a]
[a]Department of Biomedical Engineering; [b]Department of Oral and Maxillofacial Surgery, Columbia University Medical Center, NY; [c]Pennington Biomedical Research Center; [d]School of Veterinary Medicine, Louisiana State University, LA

We report a large animal study of TMJ condyle and ramus reconstruction with autologous, custom-shaped tissue-engineered bone grafts. Yucatan minipigs were randomly divided into 3 groups: condylectomy (n=2), acellular scaffold (n=6), and engineered graft (n=6). Ramus-condyle units (RCU) were chosen for reconstruction [**Fig.1A**]. Anatomically-shaped scaffolds were fabricated for each pig from trabecular bone blocks, decellularized, sterilized, and (for group iii), seeded with autogenous adipose stem cells and cultured in perfusion bioreactors [**Fig.1B,C**] for 3 weeks. At 3 months, pigs with untreated condylectomies regenerated incomplete RCU. Pigs with scaffold implantation showed significant graft resorption and fibrous ingrowth [**Fig.1D**]. In contrast, pigs with autogenous tissue engineered bone displayed regeneration as well as integration of the RCU [**Fig.1E**]. These results suggest that preformed bone can significantly enhance regeneration of TMJ compared to the scaffold alone, presumably due to its capacity for rapid formation and integration of bone matrix.

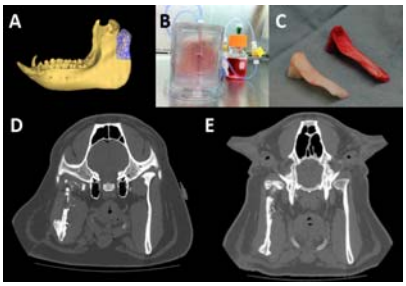

Figure 1. Tissue-engineered reconstruction of TMJ in Yucatan minipig. (A) 3D reconstructed pig mandible with selected TMJ condyle for reconstruction; **(B)** Perfusion bioreactor for cultivation of autogenous bone graft; **(C)** Engineered graft and extracted condyle; 3-month post-implantation CT image of pigs receiving **(D)** scaffold implantation and **(E)** autogenous tissue engineered bone implantation.

NOTES:

0222 Temporomandibular Joint Disorders in Dogs and Cats: A Computed Tomographic Study (2006-2011)

Arzi B, Cissell DD, Verstraete FJM, Kass PH, DuRaine GD, Athanasiou KA
1. Department of Biomedical Engineering; 2. Department of Surgical and Radiological Sciences; 3. Department of Population Health and Reproduction; 4. Department of Orthopedic Surgery, University of California, Davis

Finding an appropriate animal model to study TMJ diseases is a critical component of understanding the pathophysiology of the diseases as well as examining treatment modalities. Whether a given animal model is appropriate depends on what problem the model is supposed to address. Currently, the most commonly used animal models in TMJ research are rats, rabbits, pigs, and ruminant ungulates. Moreover, the pig TMJ disc was found to be the most similar to humans and is the current model of choice for TMJ disc studies. However, an animal model that features naturally-occurring TMJ diseases and that represents a comparative pathologic model is completely lacking. Our study's objective was to describe the naturally-occurring TMJ diseases in dogs and cats by means of computed tomography and clinical examination. We have found that the most common TMJ disorder in dogs was osteoarthritis (OA); however, in most cases OA was present in concert with other disorders. The medial aspect of the TMJ was significantly more involved in OA than the lateral aspect. The involvements of the dorsal and ventral compartments were not significantly different. In cats, TMJ fractures were the most common disorder followed by OA. Clinical signs were observed in all dogs and cats with TMJ fractures; however, symptoms were observed in only 26% of dogs and 50% of cats with a solitary OA. These findings were found to be similar to the situation in humans, where the presence of OA, as confirmed using imaging modalities, is not always accompanied by pain. However, the role of the TMJ disc in the development of TMJ-OA remains to be elucidated. The findings of this study provide a platform for our future investigations to validate canine and feline TMJ diseases as a comparative pathology animal model for TMJ disorders for the benefit of both humans and animals.

NOTES:

0223 Behavioral assays of orofacial pain for the rat preclinical model of TMJ dysfunction

Pettengill T, Alan C. Jenkins AC , M.S. Robert M. Caudle, John K. Neubert JK, Allen KD
J. Crayton Pruitt Family Department of Biomedical Engineering, University of Florida, Gainesville, FL

While pain and dysfunction are the primary reasons TMJ disorder patients seek treatment, TMJ pain and dysfunction are challenging to assess in preclinical rodent models. Recently, a rodent behavioral assay of orofacial sensitivity was developed [1]. Here, animals contact a thermode while they drink from a bottle of sweetened milk. Since the animal must tolerate the heat applied via the thermode (non-noxious, 37-57° C) to accept the reward, the frequency of reward acceptance at different temperature can assess thermal orofacial sensitivity. We recently developed a similar assay to assess mechanical sensitivity using an array of flexible cantilever strain gauges. Here, animals must accept pressure from the cantilever strain gauges in order to accept the award. Touch pressure applied to the orofacial region is recorded during reward acceptance, providing data on mechanical sensitivity. We also recently developed an instrumented toy to measure gnawing activity in rats. Here, thin film strain gauges are potted inside soft silicone, creating an “instrumented toy” that can be covered with hard candy or yogurt coatings. This treat can be used in place of the sweetened condensed milk or as an independent measure of jaw function in the rat. [1] Neubert et al. Pain 2005.

NOTES:

0231 Tissue Metabolism and Cell Development in TMJ-Disc Grafts

Seitz D, Teschke M, Schuster S

Inflammation of the surrounding tissues or cases of ankylosys are problems regarding current graft repair of jaw joints. Using cell-based repair strategies incurs both the chance and the task of creating a self-renewing implant and inducing cell that may stabilize the irritated joint via secreted signaling molecules. However, an adequate nutrition and a stable phenotype have to be guaranteed.
In order to address these questions, we have compared the physiology of disc cells to fibrocartilage (meniscus) and hyaline (knee articular, condylar) cartilage tissues. The disc showed a variable but outstanding physiology, more close to connective tissues than to other cartilages. The results are transferred to cell-seeded graft cultures using oriented collagen fibre scaffolds under mechanical stimulation in a special bioreactor, which stimulated scaffolds by simultaneously compressing and stretching the carrier.
We also investigated the development of different cartilage cell types on a range of matrix components, which can influence differentiation and may help in achieving and stabilizing the desired phenotype. Gene expression profiles were monitored in order to describe cellular reactions. Using inhibitors of the insulin, mTor and PI3K pathways we examined possible interactions of cell development with mitogenic factors in the medium which can delay the onset of differentiation.

NOTES:

0232 A Scaffold Based Approach to Reconstruction of the TMJ Meniscus

Brown BN, Chung WL, Almarza AJ, Badylak SF
University of Pittsburgh

For a percentage of TMJ patients, the only treatment that reduces pain and increases jaw mobility is meniscectomy. No alternatives exist for reconstruction of TMJ menisci following meniscectomy, and removal without replacement is increasing. A device composed of urinary bladder extracellular matrix (UBM) was investigated as a scaffold for meniscus reconstruction. 15 dogs were treated with UBM devices following either unilateral or bilateral meniscectomy. The devices remodeled rapidly and were indistinguishable from newly deposited host tissue. Remodeling was characterized by infiltration of mononuclear cells and smooth muscle actin (SMA)+ cells changing with time to a population of SMA- cells resembling those of the native meniscus. The remodeling process showed deposition of predominantly type I collagen, the density and organization of which resembled that of the native meniscus. Ingrowth of skeletal muscle was observed at the periphery of the remodeled device and was similar to that of native meniscus. Biomechanical testing showed that the mechanical properties of the remodeled device were similar to those of native meniscus. No adverse changes in the articulating surfaces were observed in UBM-implanted joints. Results of this study suggest that the UBM device may represent an effective, off-the-shelf, template for reconstruction of the TMJ meniscus.

NOTES:

0233 Nanoenhanced Hydrogels for TMJ Repair & Regeneration

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The temporomandibular joint (TMJ) is a biaxial joint that functions in articulation, food acquisition and mastication. According to the National Institutes of Health, 3-5% population of the American population suffers from some form of TMJ disorder (TMJD). This study's objective was to develop a bioactive and nanoenhanced hydrogel that is osteoconductive, osteogenic, biodegradable and will mimic the tissue microenvironment of select TMJ tissues. Calcium alginate hydrogels (2%) and halloysite nanotubes (HNTs) (1%) loaded with Bone Morphogenetic Protein 2 (BMP- 2) were produced. Osteoblasts were encapsulated within these hydrogel nanocomposites. These constructs were cultured over a 21-day period and cell behavior assessed for cell proliferation, functionality, mineralization, etc. HNTs released BMP-2 in periodic bursts that enhanced osteocyte differentiation and tissue formation as compared with controls (+BMP2/no HNT or HNTs only). Cell proliferation, mineralization and protein content increased over the experimental period. We also tested the material properties of the halloysite-enhanced hydrogels with varying concentrations of nanotubes (0%, 0.25%, 0.5%, 0.75% and 1% HNTs). Halloysite concentration of 0.25% to 1% increased the material strength of the nanocomposites. Our results suggest that HNT/alginate hydrogel composites may serve as a viable repair system for repair of damaged TMJ tissues.

NOTES:

0234 Development of a Laser Micro-Patterned Xenogenic Fibrocartilage Scaffold for the purpose of Temporomandibular Disc Tissue Engineering

Juran CM, McFetridge PS
J. Crayton Pruitt Family Department of Biomedical Engineering at the University of Florida, Gainesville Fl.

The Temporomandibular Joint (TMJ) disc is susceptible to numerous pathologies that may lead to structural degradation and jaw dysfunction. The limited treatment options and debilitating nature of severe Temporomandibular Disorders has been the primary driving force for the introduction and development of TMJ disc Tissue Engineering as an approach to alleviate this priority clinical issue. This study aimed to evaluate the efficacy of cellular integration into an acellular laser micro-patterned (LMP) freeze-dried porcine TMJ disc scaffold. The LMP is incorporated into the scaffold using a 40W CO_2 laser ablation system to drill a 10by10 pattern of 80μm holes. After gamma irradiation sterilization the scaffolds were seeded with 0.75x10^5 fibrochondrocytes/sample and either traditionally or periodic compressive stimulation cultured for 1, 7, and 21 days. The histology, cell proliferation (PicoGreen DNA quantification), and cell metabolism (BrUTP-FuGENE 6 assay) results of these works indicate that the LMP scaffold allow better cellular remodeling than the unworked scaffold over the 21 day culture. Also, the compressive biomechanical ability of the LMP cellularized scaffold cultured with compressive stimulation more closely represents the native mechanics than the non-stimulated cellularized scaffolds. The LMP TMJ disc scaffold is a promising scaffold for recapitulating the native TMJ disc characteristics.

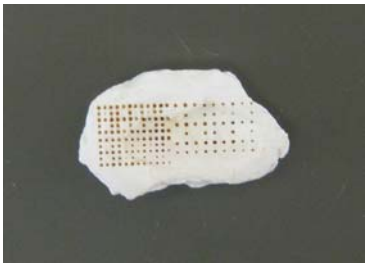

Figure 1: Example laser drilled pattern on acellular freeze-dried TMJ disc.

NOTES:

0241 Study of local and systemic changes in individuals with temporomandibular dysfunction.

Uekama IC, Regalo SCH, Semprini M, Siessere S, Bataglion C

Temporomandibular dysfunction (TMD) is a collective term that encompasses a broad spectrum of clinical problems in orofacial area. These disorders are characterized by pain, joint noises and irregular functions of the jaw, and represent the leading cause of orofacial pain not dental. It is estimated that in Brazil 8.5 million people would need some kind of intervention. It was done a survey of medical records of patients seen in Service Orofacial Pain of School of Dentistry of University of São Paulo, FORP-USP, in the city of Ribeirão Preto-SP, Brazil, between the years 2010 and 2011. Assessed-if medical records of individuals, these 117 were subjected to the classification of the Anamétido Index of Helkimo, and divided in two group, these were sub-divided in relation to gender and age group. The data were collected through interview, where individuals were questioned as to the presence of parafunctional habits, changes otologicals, ophthalmologicals, systemics and behavioral. The data were tabulated into Excel spreadsheet, and subjected to statistical analysis, using the Kruskal-Wallis test, and Miller's Test (α=0.05). The prevalence of each change was also evaluated. The results showed that TMD patients had a high prevalence in the surveyed local and systemic changes.

NOTES:

0242 Alloplastic TMJ Implants for Correction of Severe Facial Asymmetry

Quinn PD, Granquist E
University of Pennsylvania School of Dental Medicine

FDA approved alloplastic temporomandibular joint implants have been proved to be safe and efficacious for indications including: ankylosis, failed previous alloplastic and autogenous jOint replacement, posttraumatic condylar injury, avascular necrosis, post-tumor reconstruction, developmental abnormalities, functional deformity and severe inflammatory conditions that have failed to resolve with conservative treatment. Severe facial asymmetry can be congenital or acquired and usually includes marked deformity of the foreshortened condyle/ramus construct on the affected side. Both stock and custom implants have been used In combination with orthognathic surgical procedures for correction of severe facial asymmetry. We will present several cases highlighting the surgical techniques, potential complications and long-term stability of this complex surgery.

NOTES:

0311 Musculoskeletal modeling of the mandible movement and muscle forces using the Opensim software

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Laboratory for Physiology and Biomechanics of the Masticatory System, University of Zürich, Switzerland
Laboratory of biomechanics, Czech Technical University in Prague, Czech Republic

Dynamic mathematical modeling is an invaluable method to help understand the biomechanics of the anatomically and functionally complex masticatory system. Musculoskeletal models provide insight into variables which are difficult, or even impossible, to measure directly; such as joint loads and muscle forces. Individual input parameters can be modified easily to understand their influence on the function. The geometry of the presented model is based on the generic "Head and neck" model which is part of the installation package of Opensim (Delp et al., IEEE T BIO-MED ENG, 2007). Head and mandible movements are provided by set of neck and masticatory muscles. The objective of this work is to present and validate a rigid body musculoskeletal model of the "mandible-cranium" system for different mandible movement tasks. Kinematics of the mandible was recorded by "Optis" motion capture system (KFS-KAB, UZH, Switzerland) and the EMG signal, for validation purposes, was recorded by means of portable two-channel electromyographic recorder (KFS-KAB, UZH, Switzerland). Scaling of the generic model and assessment of the muscle forces and joint reaction forces was performed using inverse kinematics and inverse dynamics method.

NOTES:

0312 Friction Coefficients and Lubrication Mechanism of TMJ Disc and Condylar Cartilage

Zimmerman B, Bonnevie ED, Wang Liyun, Burris DL, **Lu XL**
University of Delaware

In TMJ, the disc glides on the condyle cartilage during daily activities. Little information is available about the frictional coefficients of these two unique cartilaginous tissues. Using a novel custom-built tribometer, we tested the friction coefficients of ten porcine TMJs. Data from five regions (anterior, posterior, lateral, medial, and central) were compared. At each region, friction tests were performed in both anterior-posterior and lateral-medial directions. We found that: 1) The disc has significantly higher friction coefficient than condylar cartilage (0.08±0.03 vs 0.03±0.004). 2) The friction coefficient is significantly lower in anterior-posterior direction for both tissues. 3) No regional difference was detected on condyle head, while the friction coefficient is significantly higher in central region on the disc. 4) The friction coefficient decreases significantly when sliding speed increases on condyle cartilage. 5) The friction coefficient also decreases at higher compressive loadings on both tissues. Histology results showed that the direction-dependent friction coefficients are related to the alignment of collagen bundles and boundary lubrication mechanisms. Finite element simulation using biphasic theory demonstrated that the lubrication on condylar cartilage is dominated by interstitial fluid pressurization. The low permeability and high proteoglycan content of condylar cartilage endows the tissue an extremely low friction coefficient.

NOTES:

0313 Effect of occlusal splints on nocturnal masseter behavior

Moser H, Vlcek D, Erni S, Cadova M, Ettlin D, **Gallo LM**
Clinic KFS-KAB, Center of Dental Medicine, University of Zurich

The mechanism of action of occlusal splints is controversial. In asymptomatic subjects, it was demonstrated that biomechanical effects on the TMJ are weak, sensitive to individual anatomies and partially neutralized by teeth clenching. Thus, other effects are being investigated. One possible mechanism is a behavioral change in masticatory muscle activity after splint insertion. Aim of this study was therefore to collect masticatory muscle long-time EMG recordings and analyze them comparing the situation without and with splint. Thirteen asymptomatic volunteers (7 m and 6 f, aged 18-45) participated in the study. Occlusal Michigan type appliances (3 mm thick in the first molar area) were fabricated in acrylic resin. Nocturnal EMG signals of the masseter on preferred chewing sides were recorded by means of portable devices at 2 kHz sampling frequency during three nights without appliance and three nights while wearing it. Activity periods (AP) were analyzed relative to maximum voluntary contraction (MVC) according to previously defined criteria. The number of AP per hour (16.2±7.0 to 13.4±6.0), their average amplitude (28.0±5.9 to 20.1±5.4 %MVC) as well as duration (7.2±3.5 to 5.7±2.9 sec) decreased significantly ($p<0.05$) when wearing the splint. These results suggest a behavioral change due to splint insertion.

NOTES:

0314 Viscoelastic dynamic characterization of the porcine temporomandibular joint disc under compression

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The aim of this study is to analyze the regional viscoelastic properties of the porcine temporomandibular joint (TMJ) disc under dynamic compression at different frequencies. The experimental programme was carried out with eleven porcine TMJ discs. The specimens were dissected from five regions of each disc: anterior, posterior, central, medial and lateral region, and tested under sinusoidal compressive strain (1% amplitude) using a range of frequencies between 0.01 and 10 Hz. As the result, the highest values of storage and loss moduli were obtained at the posterior region, followed by the central and anterior regions. The medial and lateral regions were encountered the lowest values. As general in all cases, the dynamic moduli increased with frequency. Loss tangent, tan δ, ranged from 0.20 to 0.35, which means that the disc is primarily elastic in nature and has a small, but not negligible viscosity. Experimental data suggest that the disc dynamic compressive properties are region-specific and frequency dependent, thus having important implications for the transmission of load to the TMJ. In reference to this, we would like to introduce a novel experimental methodology for the TMJ based on the adjustment of a three-degree of freedom testing machine for a more realistic simulation of jaw kinematics.

NOTES:

0321 The whole body balance and TMJ. Correlation between TMD, cervical spine pain and headaches.

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According to currently prevailing theories, temporomandibular dysfunction (TMD) is considered to be associated with imbalance of the whole body. This study aimed to investigate the influence of TMD on headaches, spinal pain and cervical spine mobility. By introducing TMD therapy we checked whether it helps to cure symptoms of headaches, spinal pain and cervical spine reduced mobility. Patients involved in the examination had their masticatory motor system physically examined, including an evaluation of TMJ function with an ultrasound JMA (Zebris) device and an analysis of the cervical spine movements using an ultrasound MCS (Zebris) device. Patients from the treated group who were diagnosed with TMD and spinal pain were supplied with an occlusal splint, usually SVED splint. Subsequent examinations of both treated and control group were planned 3 weeks and 3 months after the treatment was introduced.
The results of the study show that there is a close correlation between TMD and spinal pain. Results of tests performed 3 months after the beginning of occlusal splint therapy show a significant improvement in TMJ function as well as a reduction in spinal pain. General motor parameters of spinal movements also significantly improved.

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0322 Multidisciplinary Approach in the Management of Absolute Trismus with Bilateral Temporomandibular Joint Replacements for a Patient with Juvenile Rheumatoid Arthritis

Matthews NS

Introduction: Juvenile rheumatoid arthritis (JRA) is an exclusion diagnosis that gathers together all forms of arthritis that begin before the age of 16 years, persist for more than 6 weeks and are of unknown origin.
Background: The case of a 42 year old woman with a 16 year history of absolute trismus, secondary to bilateral temporomandibular joint ankylosis caused by JRA, is presented. The trismus resulted in grossly compromised oral hygiene with multiple carious teeth and limited the patient to a semi-solid diet. JRA also affected her ankles, knees, wrists and neck leading to a severe kyphosis of the cervical and thoracic spine to the point where her chin almost touches her anterior chest wall, thus making it impossible to access the trachea in the event of emergency surgery to establish a definitive surgical airway. Consideration was given to undertaking a cervico-thoracic kyphectomy but was subsequently ruled out due to the significant risk of morbidity and mortality. The patient who has been permanently wheelchair bound for the past 10 years developed severe lymphovenous oedema of both lower limbs, complicating the pre-operative work up further. This particularly challenging case required input from specialists in anaesthetics, neurosurgery, vascular surgery, special care dentistry, intensive care, manual handling and maxillofacial surgery.
Results: Treatment consisted of ankylosis release, dental clearance and bilateral alloplastic replacement of her TMJs with bespoke Biomet implants, designed and constructed using virtually planned web-based technology. A full range of movement and good functional outcome was achieved and the “human side” of her story was highlighted in the national UK press. **Conclusion:** This case presents the multidisciplinary approach to a severely compromised patient and illustrates the pre-, intra- and postoperative management of bilateral TMJ ankylosis with custom joint implants. It generates several points of discussion by highlighting major clinical obstacles that needed to be overcome, in order to safely deliver the patient through what was a technically demanding procedure.

NOTES:

0323 MRI and sEMG of masticatory muscles in TMD patients

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The purpose of this study was to verify if temporomandibular disorder (TMD) patients with different diagnoses had some objective differences in the surface electromyography (sEMG) characteristics of their masticatory muscles during standardized teeth clenching. Twenty-four TMD patients were categorized according to the RDC/TMD; Magnetic Resonance Images (MRI) classified patients with disk displacement (DD, mean age 22 years, SD 5; M/F: 3/6), and osteoarthrosis and/or disk displacement (OA, mean age 37 years, SD 10; M/F: 4/11); sEMG was performed according to a standardized protocol. EMG data were compared to those collected in control subjects of similar age and sex, and EMG z-scores were computed. The comparison of EMG z-scores and RMI scores between the 2 patient groups using the Mann-Whitney test was statistically significant ($P < 0.05$): the patients with OA had larger scores than the patients with only DD. The linear correlation analysis run between the EMG and the MRI scores found significant correlations in both patient groups. The EMG characteristics allowed to well differentiate patients with RMI diagnosis of DD or OA. The objective recording of the masticatory muscle function and dysfunction through EMG can be for this reason a first diagnostic approach to TMD patients.

NOTES:

0324 Observations of various muscle bundles attaching to the disc of the temporomandibular joint and the condylar process of the mandible

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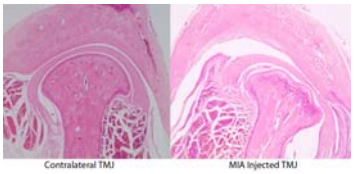
The masticatory muscles are generally described as the muscles that originate from the skull and insert on the mandible, and some of the muscles also insert into the articular disc of the temporomandibular joint. We have shown that the masticatory muscles are not simply a group of independent muscles, but that these muscles contain various transitional muscle bundles among the major masticatory muscles. We carried out minute dissection of the muscles and muscle bundles surrounding the temporomandibular joint. We dissected 50 head halves of 25 Japanese cadavers (13 males, 12 females: average 81.4 y/o). After complete removal of the bony elements of the skull, the muscle bundles surrounding the temporomandibular joint were examined en-block. In all specimens, the superior surface of the upper head of lateral pterygoid and the muscle bundle of the temporalis were attached to the disc. In some specimens, the bundles from the temporalis, zygomaticomandibularis and masseter were attached to the anterior margin of the disc. These muscle bundles pull the disc anteriorly. In contrast, the muscles to the condylar processes pulls the mandible medially. From these observations, it seems that the fibers, which attach to the disc act to steady the disc against the masticatory movement.

NOTES:

0412 An anatomic study of the insertions of the lateral pterygoid muscle
***Sakaguchi T**, Fujishiro H, Shimazaki K, Ono T, Akita K*

The lateral pterygoid muscle is generally accepted to be inserted into the pterygoid fovea. The fovea is situated on the anterior surface of the condylar process. In the present study, we examined the footprint of the lateral pterygoid to determine the area of the insertion to understand the function of the muscle. We investigated 20 head halves of 10 Japanese cadavers. After observation of the impressions on the process by using the micro CT (SMX-100CT, Shimadzu, Kyoto, JAPAN), we dissected and removed the muscles to investigate areas of the insertions to the process. The impressions shown by the micro CT were observed on the anterior surface and the medial surface of the process in all specimens. The impressions on the medial surface of the process was corresponded to the area of the insertion of the medial fibers of the lateral pterygoid. In addition, the muscle was mainly inserted to the medial two thirds of the anterior impression of the process. Based on the present results, the insertion area of the lateral pterygoid muscle is situated medial to the area, that is generally described. We might reconsider the power center of the lateral pterygoid to examine the functions of the muscle.

0413 A rat model of TMJ osteoarthritis using intra-articular injection of monoiodoacetate
***Rohrs EL**, Allen KD*



Sodium monoiodoacetate (MIA) is a known glycolysis inhibitor. Following an intra-articular injection of MIA in the rat knee, cell death, cartilage thinning, and bone remodeling is observed over 2-4 weeks, mimicking some characteristics of knee osteoarthritis. This MIA model of knee osteoarthritis has been used to study the development of knee pain and disability in the rat, allowing aspects of nervous system remodeling that associate with knee degeneration to be explored. The goal of this study is to investigate whether intra-articular injection of MIA in the rat TMJ can simulate aspects of TMJ disease. 15 µg of sodium MIA suspended in 50 µL of sterile PBS was injected in the right TMJ of 18 female Sprague-Dawley rats (MIA injected); 6 rats received saline alone (control). Injected and contralateral TMJs were harvested at 1, 2, and 4 weeks from MIA injected rats. TMJs from saline control were harvested at 4 weeks. Histological sections revealed significant joint destruction in MIA injected joints at 2 and 4 weeks post injection (Figure). Saline controls did not show deterioration. These results demonstrate intra-articular MIA injections can simulate some aspects of TMJ destruction in the rat, providing a potential preclinical rodent model of TMJ disease.

0414 Repositioning Surgery of Temporomandibular Joint Disc using a 6 mm Titanium Screw and 0 - Coated Polyester Suture
***Almeida LE**, Oliveira MA, Doetzer A*

Temporomandibular Joint Dysfunction (TMD) is a collective term used to describe a wide-range conditions affecting masticatory muscles, intraarticular and associated structures. The most common subtype of intraarticular dysfunction is the anterior articular disc displacement (with or without reduction) and when conservative treatments fails in improve signs and symptoms of this subtype of TMD, emerges a role of the surgical approach of temporomandibular joint. This report describes a repositioning surgery technique of temporomandibular joint disc by using a 6 mm titanium screw and 0 – coated polyester suture (Ethicon, Inc) attached to it. This is an economic alternative when comparing with classic methods of disc suturing using anchors and the results are very similar.

0415 Costochondral Cells in TMJ Cartilage Self-Assembly
***Murphy MK**, Hu JC, Athanasiou KA*

Engineering biological implants for addressing TMD faces the challenges of 1) identifying a clinically relevant cell source and 2) expanding donor cells while maintaining a chondrogenic phenotype. Costal cartilage, an exciting potential donor source unaffected by diseases of diarthrodial joints, has been used in autologous, maxillofacial implants. For articular chondrocytes, expansion medium and construct seeding density are potent mediators of *in vitro* cartilage formation. These methods were translated to costochondral cells to enhance functional properties of engineered neocartilage. TFP (1ng/ml TGF-β1, 5ng/ml bFGF, 10ng/ml PDGF) supplementation during expansion was hypothesized to result in mechanically robust cartilage at a lower cell seeding density (Low: $2x10^6$ cells per 5 mm construct). Both TFP supplementation and Low seeding density significantly increased mechanical properties and biochemical content. Low density with TFP supplementation resulted in a tensile modulus over 1MPa and in compression, an instantaneous modulus over 400kPa. These results represent a 57% increase in tensile modulus and a 125% increase in compressive modulus over Low density constructs expanded in FBS-containing control medium. Low density, TFP constructs demonstrated glycosaminoglycan content and compressive properties in range of native condylar cartilage. This work demonstrates potential for clinical translation of self-assembled, costochondral cells in replacing damaged TMJ cartilages.

0416 Reconstruction of Ramus-condyle Unit with Transport Distraction Osteogenesis: A Report of Eight Cases and Review of Literature

***Chellappa AAL**, Mehrotra D, Mohammad S*

Purpose: The aim of the study was to demonstrate whether the reconstruction of condyle using transport distraction osteogenesis could be a proven method for condylar reconstruction in TMJ ankylosis. **Materials and Methods:** In our study, eight patients of TMJ ankylosis in the age group of 4-16 years were included for reconstruction of the mandibular condyle using transport distraction osteogenesis and the functional, esthetic and radiographic outcome were assessed. **Results:** In all patients, the range of jaw movements were promising. There was no creation of open bite in patient who were treated on bilateral condyles. The results were evaluated clinically, macroscopically, histologically, and radiologically. This finding supports the formation of pseudo disc at the leading edge of the distracted fragment. **Conclusion:** It was concluded that reconstruction of condyle using transport distraction osteogenesis could be a proven method for condylar reconstruction in TMJ ankylosis, with no donor site morbidity as in the standard sternoclavicular graft.

0417 Biomechanics of Reconstructed condyles in TMJ ankylosis cases

***Gupta C**, Mehrotra D, Mohammad S, Singh RK*

Purpose: To evaluate the jaw biomechanics of operated unilateral and bilateral TMJ Akylosis cases where TMJ was reconstructed using condylar shaped Hydroxy Apatite/ Collagen blocks. **Materials and methods:** Twenty one patients of TMJ Ankylosis, with age range of 4 to 16 years, who reported to our outdoor patient department were included in this study. They were evaluated for chewing efficiency (Bite force recording), Range of mandibular movements (including gothic arch tracing), and occlusal discrepancies. **Results:** In unilateral cases, bite force recordings showed decreased chewing efficiency on the operated site (mean=11.2 kg) compared to normal site (mean= 14.1 kg) at 1 month follow up, but at 6 months they were comparable. In bilateral cases, bite force recordings were decreased on both sides (4.4 kg) initially, but improved with time. Mean maximal inter-incisal mouth opening on vertical mandibular motion was recorded as 36 mm. In horizontal mandibular motions, the movements were exaggerated over the operated site and restricted toward normal side. **Conclusion**: A condyle is essential to create biting force and range of motions, failing which the force is reduced exponentially, and range of motions become uncontrolled. Hydroxy Apatite/ Collagen condyle was comparable to a normal mandibular condyle in function.

0418 Development of Superselective TMJ Arthroscopic Surgery: The Combination of TMJ Arthroscopic Surgery using Double Puncture Technique and Histopathology Information of Surgical Specimen

***Fujita S**, Tojyo I, Kiga N, Matsumoto T*

We have operated more than 200 cases for serious internal derangement of TMJ (TMJ ID) with TMJ arthroscopic surgery using double puncture techniques in last 20 years. We have interested in the etiology of TMJ ID. Each surgical specimen of synovial membranes and TMJ discs were studied by immunohistochemical and biological method. In our research results, we could understand many information of histopathology finding of TMJ ID, especially the extracellular matrix; for example, tenascin showed very strong positive reaction on the some parts on the surface of synovial membranes, beneath the tenascin positive lesion we usually recognized the toluidine bule positive and VEGF rich parts, which may be able to regeneration of synovial membrane. Now we are very interested in development with super selective TMJ arthroscopic surgery, which combined TMJ arthroscopic surgery using double puncture techniques with our histopathology information.

0419 Presurgical Arthroscopy in Surgical Treatment of Diacapitular Fractures

***Hirjak D**, Machon V*

Management of intracapsular fractures of the temporomandibular joint (TMJ) remains a souce of controversy. Based on literature, conservative treatment of intracapsular fractures increases the risk for TMJ ankylosis. Our study will present acceptable functional and radiological results of surgical treatment of TMJ intracapsular fractures with more than 1-year follow-up. On the basis of presurgical arthroscopic evaluation of the status and position of the disc we determined the ideal surgical repositioning of the fragment and the disc. We believe that re-establishing the pretraumatic anatomic possition of the TMJ components is the best way to avoid a possible postraumatic TMJ ankylosis.

0420 Expression of Chondrogenetic Factors in Synovial Chondromatosis of the Temporomandibular Joint

***Tojyo I**, Shinohara Y, Matsumoto T, Kiga N, Fujita S*

Primary synovial osteochondromatosis (PSC) is a disease of unknown etiology. We classified 6 cases of synovial osteochondromatosis (SC) of temporomandibular joint (TMJ) into two type of SC, PSC (5 cases) and secondary synovial osteochondromatosis (SSC) (1 case) by means of clinical findings and hematoxylin and eosin stain. According to Milgram's classification of SC, 5 cases of PSC are classified to three different phases. In comparison with cultured synovial cells of PSC (phase-□) and internal derangement (ID) , RT-PCR method revealed obviously stronger positive reaction of FGFR-3, collagen type II, collagen type X, IHH, BMP-6, SOX-9, Wnt-14, CD44, Chondromodurin-1 in PSC than ID. More over, immunohistochemical staining of FGFR-3 was carried out for each case of SC and ID of TMJ and normal articular disc and synovial membrane. As the result of these procedures, in all three phases of Milgram's classification of PSC, positive reaction of FGFR-3 are recognized, on the other hand, no positive immunohistochemical reactions are observed in the case of SSC, ID and normal TMJ. These results indicate that the synovial membrane in Milgram phase-□ of PSC can produce cartilage nodules, as same as in Milgram Phase-□and Phase-□.

0421 Osteochondroma of the Mandibular Condyle: Reconstruction with Low Condylectomy and Orthognathic Surgery

***Wolford LM**, Dhameja A, Allen WR*

Mandibular Condylar Osteochondroma (MCO) is a unilateral benign pathological condition, with proliferation of osseous and cartilaginous tissues in the head of the condyle, causing enlargement with growth extensions that can develop in any direction off of the condyle. It is a progressive pathology often resulting in significant facial deformity, pain, and masticatory and occlusal dysfunction. Traditional treatment options include condylectomy and condylar replacement with a rib graft. This study evaluated outcomes treating MCO and associated dentofacial deformity with a low condylectomy, disc repositioning, and orthognathic surgery in a single operation. Methods: This was a retrospective study of 37 patients (28 females, 9 males), with average age of 26.3 yrs (range 13 to 48), unilateral MCO, and associated dentofacial deformity. The diagnosis for MCO was confirmed in each patient by histopathologic analysis. All patients were treated with: 1) low condylectomy, 2) recontouring of the condylar neck to form a new condyle, 3) articular disc repositioning over the condylar stump, and 4) Indicated orthognathic surgical procedures. Post-operative follow-up averaged 46 months (range 12 to 288). Patients were assessed presurgery and at longest follow-up for: Incisal opening, lateral excursions, pain, jaw function, diet, disability and occlusal stability. The pre and post surgical assessments were compared using paired t-test. Results: At longest follow-up, there was a non-significant decrease (2.3 mm) in maximum incisal opening but excursive movements decreased significantly an average of 2.5 mm (right) and 2.2 mm (left). There was a statistically significant improvement in pain, jaw function, diet and disability. 34 of 37 patients maintained a stable Class I skeletal and occlusal relation. Two patients developed relatively minor malocclusions managed with orthodontics. The tumor recurred causing a malocclusion in 1 patient who had a high condylectomy done initially. A low condylectomy and sagittal split was performed 9 months later with a stable result. Conclusions: This study demonstrates that a low condylectomy procedure with recontouring of the condylar neck to function as a condyle, repositioning of the articular disc, combined with orthognathic surgery is a viable option for the treatment of osteochondroma of the mandibular condyle.

0422 Poly (Glycerol Sebacate): A Novel Scaffold Material for Temporomandibular Joint Disc Engineering

***Hagandora CK**, Wang Y, Almarza AJ*

The preponderance of temporomandibular joint (TMJ) disorders resulting from TMJ disc injury inspires the need to further explore tissue engineering strategies. The objective of this study was to examine the potential of poly (glycerol sebacate) (PGS), a biocompatible, biodegradable polymer with elastomeric properties as a porous scaffold material for the TMJ disc. Goat fibrochondrocytes were seeded on PGS at low, medium, and high seeding densities (25, 50, 100 million cells/ml scaffold, respectively) and cultured for 24 hours, 2 weeks, and 4 weeks. The resulting biomechanical, biochemical, and histological properties were determined. Unconfined compression testing revealed a significant increase in tangent modulus over the four week period in the cell seeded scaffolds. At 4 weeks, the tangent modulus of the low seeding density group was in a similar range of the goat TMJ disc (180±127 kPa compared to 304±141 kPa, respectively). The PGS scaffolds also supported the deposition of large quantities of extracellular matrix and the high density seeding group had a statistically significant increase in collagen and glycosaminoglycan content over time. In the high seeding density group, there was 3.5±0.5% collagen and 12.1±2.3% glycosaminoglycan (GAG) per dry weight at 4 weeks compared to 45.7±19.6% collagen and 2.1±1.2% GAG per dry weight in the goat TMJ disc. There was also a significant increase in cellular content over the four week period, showing that the scaffolds allowed for both cell attachment and proliferation. The results demonstrate that PGS has great potential as a scaffold material for TMJ disc engineering.

0423 Micro-CT Analysis of Magnesium Screw Degradation in a Rabbit Model
***Henderson SE**, Chung WL, Chou DT, Kumta PN, Almarza AJ*

Recently, magnesium (Mg) alloys have been studied as a potential biomaterial for degradable implants. To begin testing the effect of degrading Mg in craniofacial bone, the objective was to implant commercially available Mg-alloys as screws in a rabbit mandible, and assess bone formation and Mg degradation. Pure Mg (99.9%) and Mg-alloy AZ31 (3%wt aluminum, 1%wt zinc) screws were implanted in to the mandible of skeletally-mature, female, New Zealand White rabbits for 4, 8, and 12 weeks (n=3). Micro-CT analyses were performed to measure bone formation and examine the degradation of the Mg at all time points. Histology was completed on the 12 week samples. Overall, the pure Mg screws had degraded more rapidly than the AZ31 by exhibiting lesser volumes remaining as calculated from the micro-CT ($p<0.05$). Histology showed in some locations the shafts of the pure Mg screws were completely degraded at 12 weeks. In some cases, bone overgrowth was observed and overgrowth was more pronounced at 12 weeks. Our results show that clinically relevant craniofacial bone remodeling occurred around both screw types, and the bone-metal interface remained viable up to 12 weeks on the AZ31 screw. These results indicate the promise of using Mg alloys for craniofacial applications.

0424 GFP reporters in the TMJ condylar cartilage and the response to mechanical loading
***Utreja A**, Jiang X, Nanda R, Rowe DW*

The TMJ fibrocartilage is a useful model for exploring lineage progression in the resting state and in response to mechanical loading. In the process of developing and analyzing green fluorescent protein (GFP) reporters, we have realized that the lineage progression pathway in fibrocartilaginous structures is: SMAA -> Dkk3 -> Col1A1-3.6 -> Col2A1 -> Col10A1. **Methods:** Experimental mice carrying the Dkk3-eGFP x Col1A1-3.6-GFPcy transgenes underwent forced jaw opening with a custom spring exerting 50 grams force for 1 hour/day for 5 days whereas the controls did not receive any force. Alizarin complexone and EdU (a BrdU analog) were injected 24 hours prior to sacrificing the mice, and cryosections of the non-decalcified mandibular condyle from experimental and control animals were compared. **Results:** The loading regimen increased the number and depth of Dkk3-GFP cells as well as the number of EdU-positive cells. In addition, the intensity of the tidemark labeling diminished in the loaded animals. **Conclusions:** TMJ loading activates the progenitor cell population and reduces the barrier separating the cartilage from the underlying bone. Knowledge of this cellular response is essential from a bioengineering perspective to gauge when the capacity of the response is exceeded and leads to cartilage destruction.