THE FIFTH ANNUAL CODMAN SHOULDER SOCIETY MEETING

SATURDAY, JUNE 23RD (3:15-8:30 PM)
Hilton San Diego Bayfront, Conference Center Room 310

"Give me something that is different, for there is a chance of its being better." – EA Codman, 1934

This year we are honored to have Dr. Christian Gerber and Dr. Gilles Walch as our Keynote Speakers.

3:15-4:00 JP Warner: Welcome cocktail reception *(Conference Center 3rd Floor, Aqua Terrace Foyer)*

3:50-4:00 Group Photograph

4:00-4:10 **Joaquin Sanchez-Sotelo: Program Introduction**

KEYNOTE SPEAKERS

Gilles Walch, MD **Christian Gerber, MD**

KEYNOTE ADDRESS: HOW DO WE GET 'BETTER' AND WHY DO WE INNOVATE

MODERATOR: JON TICKER

4:10-4:20 **Gilles Walch's View**

4:20-4:30 **Christian Gerber's View – To be presented by Dr. JP Warner**

4:30-5:00 **Discussion**

SESSION I: THE ROTATOR CUFF

MODERATOR: LAWRENCE GULOTTA

5:00-5:10 **Ed Yian: When Should We Repair a Torn Rotator Cuff? Factors Predicting Reparability, Healing, and Clinical Success**

5:10-5:30 **Mini-Debate: Which is my Preferred Transfer in 2018 for a Posterosuperior Irreparable Cuff Tear?**

- *Bassem Elhassan: Arthroscopically-assisted Lower Trapezius Transfer*
- *Eric Wagner: LD vs LT vs SCR – what are the differences in outcome?*

5:30-5:40 **Gilles Walch: Reverse for Irreparable Cuff – Pearls to Optimize Outcome**

5:40-6:15 **Case Presentations from CSS Members on Rotator Cuff**
Panelists: Gilles Walch, JP Warner, Joaquin Sanchez-Sotelo

6:15-6:30 **BREAK**

SESSION II: SHOULDER ARTHROPLASTY

MODERATOR: RONALD NAVARRO

6:30 -6:40 **Gilles Walch: How can we Improve Durability of Anatomic Glenoid Components?**

6:40-6:50 **Larry Gulotta: How can we Predictably Improve Internal Rotation in Reverse?**

6:50-7:00 **Joaquin Sanchez-Sotelo: How can we Optimize Reverse for Fracture?**

7:00-7:30 **Case Presentations from CSS Members on Shoulder Arthroplasty**
Panelists: Gilles Walch, JP Warner, Joaquin Sanchez-Sotelo

SESSION III: WORKING DINNER DISCUSSION—Our First Multicenter Study

MODERATOR: JP WARNER

7:30- 8:30 *Dinner will be served as we discuss our strategic vision, future research goals, and organizational structure.*

On behalf of JP Warner and the C.S.S., we would like to formally thank Dr. James Esch, Larky Blunck, and the San Diego Shoulder Institute for their generous support and sponsorship

Codman Shoulder Society Meeting 2018
Group Photo

Front Row:

Tim Hartshorn, MD (Pvt. Prac, MA), Brett Sanders (Pvt Prac, TN), MD, Jon Goff, MD (Pvt Prac CA), Laurence Higgins MD, MBA (VP Arthrex) Bassem ELHassan, MD (Mayo Clinic), Jim Esch, MD (President- SDSI), Jon "JP" Warner, MD (Founder, CSS), Gilles Walch, MD (Pvt.Prac., Lyon, Fr) Joaquin Sanchez-Sotello, MD, PhD (Mayo Clinic), Jon Ticker, MD (Pvt. Prac, NY), Larry Gulotta, MD (HSS, NYC), John Costouros, MD (Stanford, CA), Emily Cheung, MD (Stanford, CA)

Back Row:

Alex Prete, RA- (Boston Shoulder Inst.) Felix "Buddy" Savoie, MD (Tulane, LA), Derek Haas, MBA (President: Avante Garde Healthcare), Ed Yian, MD (Kaiser Permanente, CA), Eric Wagner, MD (Emory, GA), Xining "Tiger" Li, MD (Boston University, MA) Cory Stewart, MD (Mayo Clinic, WI), Lewis Shi, MD (Univ. Chicago, IL), Markus Rauscher (Dir-Global Brand, Zimmer), Peter Vezerides MD (Pvt. Prac. MA), Pancho Sosa, MD (Pres., Chilean Shoulder Society), Scott Pennington, MD (Pvt., Prac. GA), Anshu Singh, MD (Kaiser Permanente, CA), Jeremie Axe, MD (Pvt. Prac., DE), Michael Freehill, MD (Univ. Michigan) Amit Sood, MD (Pvt. Prac. NJ), Jeff Zanni, (Regional VP, Wright), Kyong Min, MD (US Army), Vince Fath, (VP Sales, Wright), Ruth Delaney, MD (Pvt. Prac., Ireland), Jean Chaoui, MBA (VP Strategy, Wright), Katie Fedorka, MD (Pvt. Prac., NJ), Matt Van Horn, Dir. Prof. Ed., Smith & Nephew) Emma Zumsande, CNP (Boston Shoulder Institute)

(Former Fellows denoted in Blue)

Click here for a high resolution image

Welcome & Overview of the Codman Shoulder Society®

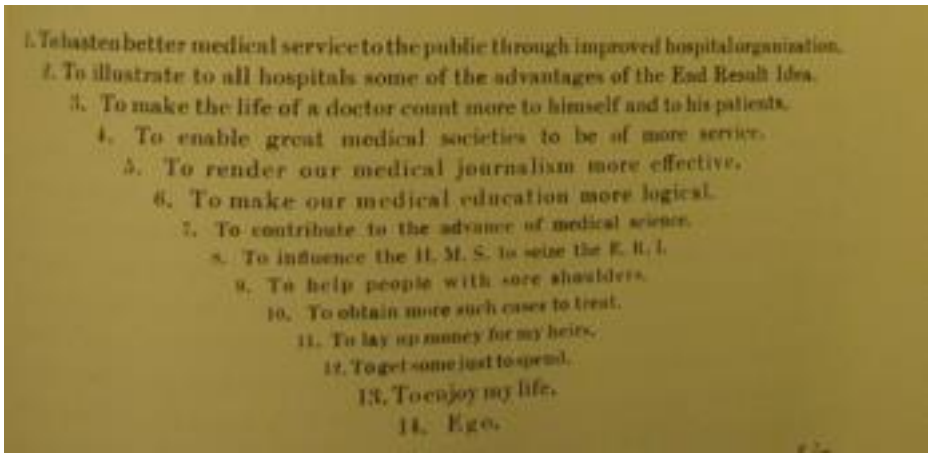
JP Warner: I want to thank everyone for coming. This is the fifth time we have held this meeting. It rapidly became apparent to me that this evolved from an initially what was an alumni group to really a think tank, and everyone is welcome. In fact, I go out of the way to try to make us as diverse as possible. I want to point out a few changes that happen every year, and also make sure everyone understands I want your input on future direction for this group. How I can change this program in order to continue to benefit our group? How can I grow this as a meaningful network for us to work together that provides value to our patients, industry and our institutions? We know this meeting differentiates itself from educational programs like San Diego Shoulder Institute, and I'd like to thank Larky Blunk and Jim Esch for their continued support of our program. For those of you who flew in just for this meeting, thank you so much, it really warms my heart; for those of you who stayed, thank you for your endurance, because it really has been a long week, and just a few words. I invite industry every year and I am happy that they come; I want to hear their perspective as I want all boats to float. This isn't about anyone's particular interests and if you detect a bias, please call it out; you will not hurt my feelings. The second thing is that we have visitors from outside of industry that have an interest in business, everything from data analytics, AR to VR and etc. I think that this will be unique, because I want to call on everyone to think out loud with us. I am more interested in what you say than what we say, and we have to start somewhere to stimulate thought.

One final note. Unfortunately, Christian Gerber cannot be with us this year as he is ill and cannot travel. We wish him a speedy recovery. He has graciously sent me his presentations and I'll try to do my best to represent his ideas and concepts. With that as a backdrop, Joaquin Sanchez-Sotello will moderate the first session.

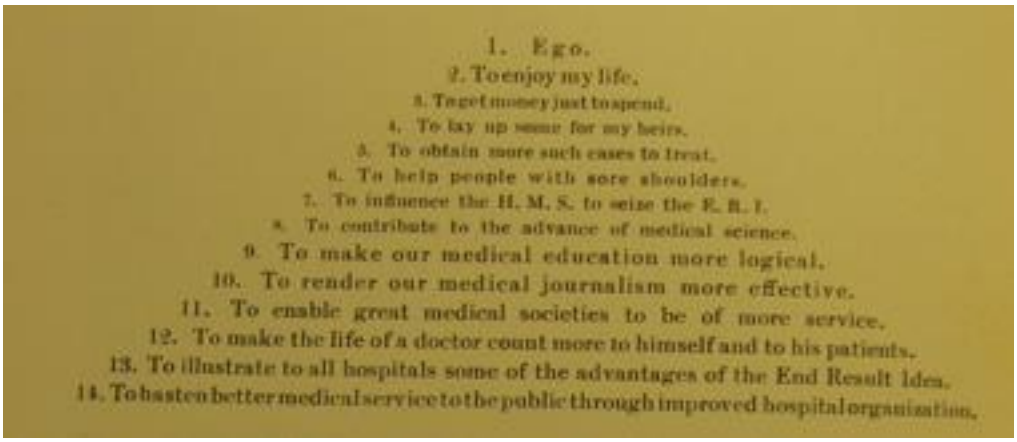
Dr. Sanchez-Sotello: Welcome everyone. It is very nice to have our meting number five for the Codman Society. So my role today is to give you an overview of the program, and to remind you that this society is named after Dr. Codman, who passed away a long time ago. However, I believe that we have a reincarnation of Dr. Codman in Dr. JP Warner. I

think it should be renamed, by proposal, the Codman-Warner Society eventually. JP, it is just amazing that you are able bring together people from so many different environments. We were supposed to have Dr. Christian Gerber here, but unfortunately he could not make it to this trip. However, to some extent, it does not matter because I think JP can read his mind. So, the first portion of the program is about innovation with an introduction by John Ticker. Then, JP will present the view of Christian Gerber about innovation. Of course, we have one of the thought leaders of shoulder surgery here, Dr. Gilles Walch, who is such a gentleman. I think it is difficult to change the practice of medicine, but I think it is safe to say that Dr. Walch you have changed the way we practice in so many ways, from the Latarjet procedure to the classification of glenoid deformity. I think that, at the end of the meeting, Dr. Warner is really interested in having all of us think: what do we want this society to be? And I think, to me, it is about the shoulder; I know you know the elbow too, but we will try to focus only on the shoulder. The aspect of this society that is potentially different is that Dr. Warner has always emphasized value and evidence, and I think we have to envision this group as a group that can work together in the shoulder area to provide value and evidence. Because we are all good friends, it is easy for us to do something that is actually difficult, as we can think about multicenter studies. So with that brief introduction, you can see that the program has three sessions. Session one is on innovation, in which we will talk about rotator cuff. Dr. Gulotta will be the moderator for this section, and then Dr. Warner will moderate session 2, "Shoulder Arthroplasty." We tried to leave time for cases and discussion, and we want you to be interactive. Hopefully, you can all participate! So with that, John…

Dr. Ticker: It actually came out of a discussion that JP brought to me: how do we get better and why do we innovate, or, if you we want to look at, why do we get better and how do we innovate? There are a number of different ways of looking at it. But I thought I would (as we all do) revert back to Codman. In his epilogue, he really clearly described what his motivations are in practice. You can see this pyramid (see below), if you all recall in the back of the book. "Better medical service," I'm not going to read all of these, but down at the bottom there was financial, enjoying life, and then ego. And that was in the earlier part of his career. As his fortunes changed, he changed the pyramid in the other direction. And so it does depend upon where you are in your practice and where you are in your life, but obviously 84 years ago he described his motivation for what he did in his career. I just wanted to keep that reflection.



From Codman: The Shoulder. Epilogue, P. 15: In times of plenty the surgeon's Ego and his needs are at the bottom of priority. The first priority is "To hasten better medical service to the public through improved hospital organization."



From Codman: The Shoulder. Epilogue, P. 14: In lean times, when the business of healthcare is not so good, the priorities reverts to the surgeon's "Ego" and "to enjoy my life" and "to get money just to spend."

We will hear first from Gilles, and we will get a wonderful perspective from a world-renowned expert who invited me about 20 years ago. It was wonderful to come visit you and learn, and I appreciate it all.

Keynote Address: How Do We Get "Better" and Why Do We Innovate

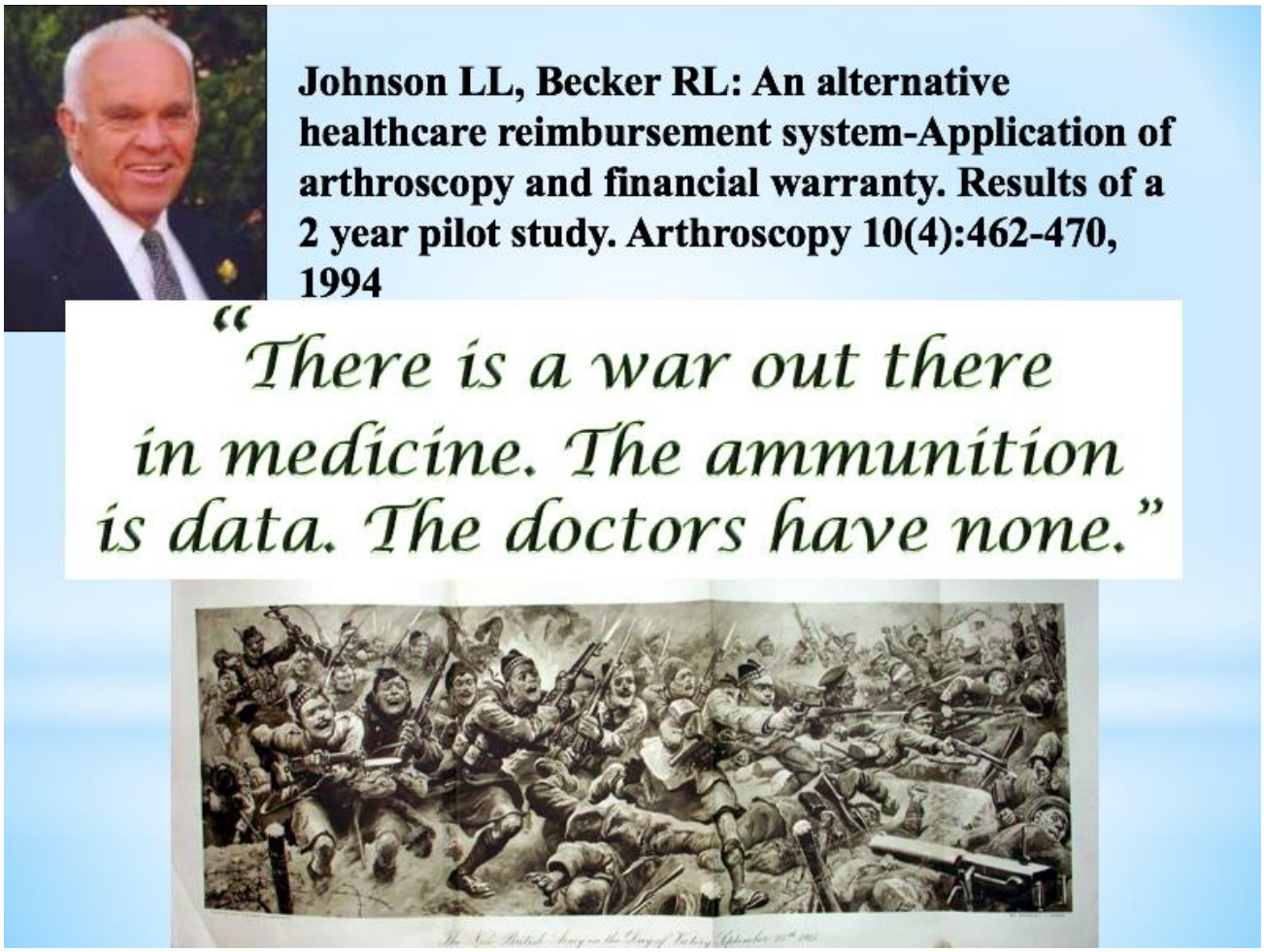
Dr. Gilles Walch Keynote address: "How Do We Get Better and Why Do We Innovate?"

Dr. Walch: So, thank you before everything. Thank you JP, thank you for inviting me here. Thank you for being my friend. We have known each other for 30 years now, and you are a familiar kind of inspiration. I think that as Joaquin said, you could call this society the Codman-Warner Society, because you are a giant of a shoulder surgeon. You are not only an excellent surgeon, and fantastic surgeon, a master, but you are also a fantastic teacher; and when I see this society, I see all the people you taught, and I just think that you are fantastic professor. You deserve to be from Harvard, because Harvard for us in Europe is something that is always fantastic. We believe that the best is from Harvard; true or not true, that is how we feel. And you are this good. The first time I spoke in the U.S. was at a Partners meeting in Pittsburgh (1993), and you invited me. I said, "You know my English is so poor I don't want to go." You said, "Come, and we'll see." And that was my first time in the U.S. thanks to you. So, you have given me the opportunity to meet so many young people. You send your fellows to Lyon, and it was a great honor to have some of you coming to Lyon for one month sometimes. And everything like that is thanks to you, so thank you and congratulations for what you have done.

(Click here for a PDF of Dr. Walch's Presentation). Note to viewers: I have edited this presentation to place in quotes some of the points Gilles Walch made at our meeting. Please view this pdf and consider his words. – JP Warner, MD

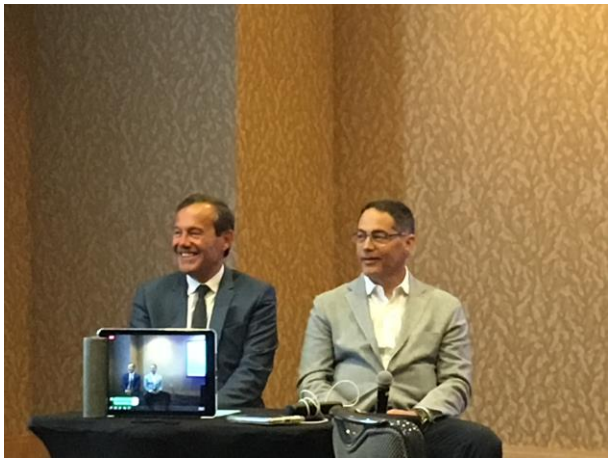
Prof. Christian Gerber Keynote Address: "How Do We Get Better and Why Do We Innovate?" (Presented by JP Warner)

JP Warner: So let me make a few comments to start with. The first is that, one of my professors from Harvard Business School, Bob Kaplan, said "***If you can't measure, you can't manage it, and if you can't manage it you can't improve it",*** This fits perfectly with what Gilles Walch just presented. He talked about measurement, and I've been saying that all along. Our biggest problem is that we don't measure. It was Dr. Lanny Johnson (who some of you may not know) who was the father of modern arthroscopy and also an extremely successful businessman who believed in the power of measurement and reported on this several decades ago. He proposed measuring outcomes and collaborating with an insurance company to create a bundle for arthroscopic surgery of the shoulder and knee 25 years ago; and showed it improved his margins. (See below). So I think that's an important point to make here and that you all should go home and do that tomorrow. The other thing that I learned and why I'm qualified to give this talk, is that when you are a student the best thing you can do is find someone worth imitating. And Christian Gerber had played a role in my life for about 30 years. Let me just say a few words about Codman and why this started. Jon Ticker showed you a little insight into the man Codman was. One of my favorite quotes which Jon thought of for our organization is: "give me something different, for there's a chance of it being better." And after all what we want to do is ask questions. And this group originally started as an alumni group for our past, but it was quickly apparent that it needed to expand beyond that. I certainly wanted to expand to the critical mass to get things done that are meaningful, and fulfilled the "End Result "concept of Codman. I would encourage all of you to go to Warner's Corner on the Codman Shoulder Society Website. My commitment is to make this endeavor an ongoing process, and even though we only meet once a year, my job is to make you a better product, and if you are a better product in what you do, then your patients will do better.



([Click here for a PDF of Dr. Gerber's Presentation](#))- Note to viewers: Please read the slide and the comments from Prof. Gerber at the bottom of the slides.

Discussion with Dr. Walch and Dr. Warner (on behalf of Prof. Gerber):



Dr. Ticker: So there clearly was a common theme: You both mentioned the most important part about how to get better, which was to listen to your patient. And the longer you practice, the more you realize that that is the most important part. Gilles, I have a saying over my desk at home: ***"Good judgement comes from experience, and experience often comes from bad judgment."*** So, if you don't learn from your mistakes, you are doomed to repeat them. Are there any questions from the audience? What I wanted to know from you guys: I am in a private practice setting. I started in this small little corner in Long Island. I had partners who did nothing that I did, and left me alone to my own devices. I thought that was a great environment for me to prosper. But yet there are people at major institutions…Dear Larry Gulotta is at an institution where there are…how many shoulder surgeons? Yet there is still the opportunity to create and grow.

Dr. Gulotta (Hospital for Special Surgery): There are 32 shoulder surgeons at HSS.

Dr. Ticker: So what is the best environment for someone to be in, and what are the pros and cons? This is obviously individual, but do you think you can be stifled in an environment like that?

Dr. Warner: I think that it is very important that we should recognize that the French shoulder community has something that is really valuable. That is willingness to collaborate. They have produced multicenter study after study with large enough numbers to avoid what Mohit Bhandari has told us about study fragility (see Codman Shoulder Society Meeting in 2016). This occurs when a small "N" makes conclusions less likely to be valid from a study. In fact, the French multicenter study on durability of reverse prosthesis has given us very important insights into the longevity and mode of failure of reverse implants after 10 years. I really encourage everyone to look at that work. (Ascione F, Domos P, Guarrella V, Chelli M, Boileau P, Walch G. J Shoulder Elbow Surg. 2018 Jun;27(6):1065-1071: 10.1016/j.jse.2017.11.028. Epub 2018 Jan 4: Long-term humeral complications after Grammont-style reverse shoulder arthroplasty.)

Dr. Walch: I agree with that. I think that it is nice to have a good team, a large team, that is not the problem. The only problems I saw in my life are not because of competition, scientific competition. The only problem you can observe is when there is some money in between two surgeons, two friends. That's definitely an obstacle that may prevent you from improving. Otherwise, I believe that to have many different partners is probably a good opportunity to improve yourself, to discuss, to exchange about problems and find solutions.

Dr. Warner: I have very tangible examples here. I mean for 13 years Larry Higgins and I worked together at Harvard. There is no question that the two of us together accomplished much more than we could have accomplished alone. At Mayo Clinic Joaquin Sanchez-Sotelo and Bassem Elhassan work together in a dynamic collaboration. We can name so many dynamic duos outside of Orthopedics. For example, Watson and Crick who defined the double helix of DNA, Kahnman and Tiversky who defined the science of Behavior Economics. So collaboration is essential to inspiration and accomplishment. Now that is the minimum too; it is even better if there's more than one

partner in collaboration. Those kinds of collaborations make a huge difference. We all of us probably have the experience of disappointment in not being able to assemble such collaborative groups. This is true of Academic Medical Centers like HSS or MGH and BWH. Partners Healthcare is a 12.5 Billion revenue organization, but collaboration remains a challenge in orthopedics and likely in other areas. At Harvard Business School, Haas and Kaplan have written about how hospital finances are a barrier to innovation in large academic medical centers (Haas, DA, Jellinek MS, Kaplan RS: Hospital Budget Systems are Holding back Innovation, HBR, 2018- see Warner's Corner on the CSS Website).

We may however have some notable exceptions in organizations that have worked to create registries. I know Kaiser has done this and Ron Navarro and colleagues have reported on this in past CSS meetings.

Dr. (Ruth) Delaney, Ireland: One of the many things that I admire about both of you is your honestly and your ability to report your bad results, Gilles was talking about this. And is that something that you developed courage for over time, or is that something you guys were able to do from day one of practice? How do you arrive at the point where you are not afraid to tell everybody something you thought would work doesn't work?

Dr. Walch: That is a very good question; I do not know. No, I cannot say that I was true to report my bad results. I was true to analyze the bad results, and then it is more difficult to report the bad results. It is something you get from your personality. Some people hate to speak about poor results. I remember one day in the U.S. one surgeon said, "You know, Gilles, I just reported 50% recurrence rate after the modern procedure for anterior instability." It was an arthroscopic stabilization back in 1987, so 50% recurrence rate for complications. One surgeon said to me "Gilles, I do not know how you do that, how you publish your bad results because if I wanted to do this I would never see any more patients." So, there is something to see with your personality: if you believe you get patients because you lie… I don't know, it is a problem of personality.

Dr. Warner: You know it's really interesting. I think that is true, and it came through in Gerber's words here. I knew it, I knew I wanted to do it, I knew that when I went to Harvard I read Codman's work and I knew I wanted to replicate his vision, his approach to what he did. It wasn't until 2012 when I spent time in an executive program at Harvard Business School with Michael Porter that I understood something of a formula to do it. Even before then, Larry and I measured every single patient's outcome. The way we do it is really interesting and important: I don't measure, I have my team measure and tell me how the patient does. The truth of the matter is, we would get together quarterly and analyze our outcomes and, from that analysis, improve those outcomes. We could

actually see our improvement. We published our learning curve for reverse arthroplasty. It was an incredibly good business decision because when you show how good you are and there's no comparison in the marketplace, and you show the process by which you got there, your problem is just dealing with the volume of patients that will come your way. So honesty actually is a good policy!

Dr. Ticker: One perspective I have is your measure and level of confidence. Both of these gentlemen are confident in what they are doing and why they are doing it. This is from the point that they start, from the thought process, the principles, everything that they put in, and this has built on a strong foundation. So they have confidence that what they are going through is the right course. That has been my impression, that it has to do with a sense of self-confidence in what they are doing. So, I certainly see that in both of you. I wanted to find from the industry, and I asked **Matt Van Horn** (Director of Professional Education for Smith and Nephew) if he would give us a perspective: When you are looking at a prospective surgeon, what do you look for in an individual that you might want to work with, to see if they can help you innovate?

Matt Van Horn, Director of Prof Ed. For Smith and Nephew: That's a good question. It is multifactorial decision in that in our organization, it is a combination of need to have been identified by existing consultants combined with our research and development teams, our marketing teams, and professional education. But in terms of characteristics, first and foremost, we look for surgeons who have already begun their journey beyond their training with a foundation built on a fellowship. Secondly, we prefer someone that is still actively publishing research, because it is indicative of the passion to improve outcomes as well as contribute to the development of others. Thirdly, active involvement as an attending with an existing fellowship program, because whether it's business or surgical training, I think it is important to have well identified mentors, and again someone that is willing to contribute to the development of others. And then lastly, someone with a combination of both good interpersonal skills and patience, because I

think we all saw it in the lab the last couple of times: it is one thing to be an effective presenter from the podium, but sometimes whenever you are in the lab things can be kind of challenging. We want to make sure that whoever is there has positive experiences regardless of what their level experience is before they go in the lab.

Dr. Warner: I am sorry to put you on the spot there, but I have to do this. **Derek Haas** is president of Avant-Garde Health (https://www.avantgardehealth.com) (Also see write-up in "Warner's Corner" on CSS website), which is a data analytics company that is grown out of his experience and passion at Harvard Business School. This company is all about delivering value, and maybe he can say a few words about measurement, value, and the future, as well as provide some perspective for us. How about that? Anything you say will be worthwhile.

Derek Haas, MBA: Thanks JP. It has been a pleasure knowing JP and also Larry (Higgins) for about five years now through their involvement with value-based research work at Harvard Business School; I'm working with two of the faculty members there, Mike Porter and Bob Kaplan. About 3 and half years ago, I spun off a business from that research work called Avant-Garde Health, which is also based in Boston. So we provide software that is used to help organizations understand the real costs of the outcomes of their care both inside their institutions as well as across the rest of the care continuum. The goal is helping people to understand how they are doing, and where they have opportunities to learn and continue to innovate from a care process and methodology perspective to be able to continue to improve their performance over time. I am not a doctor myself; my mother, father, brother, and sister are all doctors, and so I grew up hearing about all the different challenges and frustrations that you all experience, and so it brings me a lot of satisfaction to do what we are doing. Again, our goal is not to say, "Here is the right way to deliver care," but to give people the insights and provide them the time to reflect and ask the questions that you are all trained to ask to understand how we are doing, how are other people approaching care in the same or different ways, whether in the same institution or across other institutions. So you can see how other people are delivering care, and are they getting to the same or better outcomes at different levels of cost. That ability to be able to have introspection and to be able to just examine the data in a neutral way is something that people really find valuable to try to drive improvements in their care and care delivery. So our goal is to really help people look at that goal-care continuum, so you can understand too if you are changing one part of the care, is there an impact later on throughout the rest of the care continuum. And so we really want to try to help folks bring together as much information inside all aspects of their care as possible. I definitely appreciate that many of you all are collecting your patient recorded outcomes today, and it's really fascinating to look at along with information about care costs and care processes together. Sorry that was not more insightful.

Dr. Ticker: No no no! And I just wanted to share with you: we can debate Dr. Neer's contributions to say impingement, but how he came upon that was McLaughlin wanted to find out what his results were for lateral acromionectomies, so he learned by looking up McLaughlin's results, and found that lateral acromionectomy was not the way to go. He came up with anterior acromioplasty from that. I also did some research at the Hamer Health Sciences Library when I was at Columbia and found this book "The Obstructing Acromion," which was written by a guy named Diamond and you can find a copy online. It is a very interesting book, and it's just a guy in private practice who talked about how the acromion was the offending structure and I know Neer looked at that book; it was in his collection, in addition. So you can learn a lot just by looking back, and that's just one more example of a major contributor in our field who took that opportunity to look at outcomes. But he may not have had the right conclusion, but the operation…do you still do an acromioplasty with your cuff repairs?

Dr. Walch: Yes I do because I do not see any adverse effect. I realize that in a young patient if it's a traumatic tear, it is probably not a good question. More and more, I see a massive rotator cuff tear in the young patient but that includes superior glenoid inclination, then it causes that shape, for sure, and that will be part of the next step in our comprehension. Yes, if I do a standard cuff repair, degenerative case, 58 years old, I have no reason to not do an acromioplasty. So people say that it does not help; yes I know. But I do not see any see any adverse effects on my patients, so why change something if I do not see any adverse effects.

Dr. Warner: I do it so I can see and do an easier operation, and then more and more now… I am looking preoperatively at the critical shoulder angle (CSA) as described by Gerber, and if this is high, I am trying to shorten the lateral acromion, I just don't know if it's going to make a difference. But Gerber has made a strong argument for this as a cause of rotator cuff tears. (Moor BK[1], Bouaicha S, Rothenfluh DA, Sukthankar A, Gerber C.: Is there an association between the individual anatomy of the scapula and the development of rotator cuff tears or osteoarthritis of the glenohumeral joint?: A radiological study of the critical shoulder angle. Bone Joint J. 2013 Jul;95-B(7):935-41; Moor BK[1], Wieser K[2], Slankamenac K[3], Gerber C[2], Bouaicha S[3].: Relationship of individual scapular anatomy and degenerative rotator cuff tears. J Shoulder Elbow Surg. 2014 Apr,23(4):536-41); Gerber C, Snedeker JG, Baumgartner D, Viehöfer AF.: Supraspinatus tendon load during abduction is dependent on the size of the critical shoulder angle: A biomechanical analysis. J Orthop Res. 2014 Jul;32(7):952-7.; Viehöfer AF, Gerber C, Favre P, Bachmann E, Snedeker JG.: A larger critical shoulder angle requires more rotator cuff activity to preserve joint stability. J Orthop Res. 2016 Jun;34(6):961-8; Gerber C, Catanzaro S, Betz M, Ernstbrunner L.: Arthroscopic Correction of the Critical Shoulder Angle Through Lateral Acromioplasty: A Safe Adjunct to Rotator Cuff Repair. Arthroscopy. 2018 Mar;34(3):771-780.; Beeler S, Hasler A, Götschi T, Meyer DC, Gerber C.: The Critical Shoulder Angle: Acromial Coverage is More Relevant than Glenoid Inclination. J Orthop Res. 2018 May 18. doi: 10.1002/jor.24053. [Epub ahead of print].

Dr. Walch: It is such a pity that Christian is not here to discuss that because the critical shoulder angle is called the acromion shape, and he said, "No, it's the superior angulation of the glenoid." The acromion length has no relevance for me in the critical shoulder angle and the consequences are very different because if you call it superior angulation, that means that what you should do is maybe a kind of osteotomy in order to decrease he superior inclination. But Christian is not here so this is unfortunate as he cannot answer this here.

Dr. Warner: This is really interesting. The retort I would make to Gilles is this: Gerber first described the acromion index, which the length of the acromion, and he found the correlation that it had nothing to do with the glenoid inclination, which is of course, part of the CSA. Then he looked at the superior inclination angle of the glenoid, and put it together to make the critical shoulder angle. So how would you discount the acromion length analysis, which says nothing about the inclination. (See references above)

Dr. Walch: Yes it does, because we measure the length of the acromion on the AP view, so if you have superior inclination of the glenoid, the length of the acromion is bigger.

Dr. Warner: Pity he's not here. Maybe we are going to have an answer in time, but if you believe one thing is it really right? One of us is wrong and probably Gerber is right anyway.

Dr. Ticker: We all love to talk about the acromion, which is fascinating. For your next 20 patients who have stiff shoulders, look at their acromial shape, and record that. You will find that most of them have a Type 1 acromion. Look at your calcium patients, Type 1 acromion, if you believe in acromial morphology. So there's a lot that you can learn just from the X-ray just before you go in the room for that 52 year old lady with stiff shoulder. Think about all the critical aspects of everything you get, and you will learn a lot. I think we are good for time!

Session I: The Rotator Cuff

Dr. Larry Gulotta (HSS): Thank you very much, that was great. We are going to move on to Session I: The Rotator Cuff. I will be moderating, and we are going to talk about how we repair rotator cuffs and the role of tendon transfers; and Dr. Walch is here to give some of his insights on the world of reverse shoulder replacement. So, I do have a case to perhaps set the stage here. Consider a 45-year-old, right-hand dominant man. He has a 3-year history of right shoulder pain, weakness, and he had a fall three years ago in which he injured his shoulder; He was normal prior to that. He never sought treatment. He just dealt with it because he did not have any health insurance. Now he finally has health

insurance and comes in and presents to me with pain and limited motion. His active forward flexion is 120 degrees, passively he can get up to 160 degrees, and he is weak and needs a little bit of help to get from midrange up to about 160. He does have a lag up to about -10 degrees of active external rotation with his arm down at his side, but passively he goes to about 20 degrees; his internal rotation is to his sacrum. He is weak in his supraspinatus as well as external rotation, but his subscapularis is strong with a negative belly press. So his X-rays are normal. On his MRI coronal images, he has a massive rotator cuff tear with some humeral head elevation. The outside MRI does not have a T-1 Sagittal so it is difficult to comment on fatty atrophy; however, the infraspinatus does look to be completely atrophied. But the rest of the rotator cuff musculature looks good, and he probably even has hypertrophy of his teres minor. So, treatment options here would be non-operative, repair, partial repair, patch grafting, Superior Capsular reconstruction (SCR), latissimus transfer, or lower trapezius transfer. Bassem you know that you have come up with something that becomes mainstream when you have acronym for it now. People talk about the "LTT- Lower trapezius Transfer"- you know, you are making some headway in our reverse shoulder replacements. So that sets the stage. We will go through the talks and then we will get to the case presentation part when we will come back and talk about what you guys would do in conclusion to the case. But first off is going to be Ed Yian, and he is going to talk about when we should repair a torn rotator cuff, factors predicting reparability, healing, and clinical success. Ed…

Ed Yian (Kaiser-Permanente, Southern California): *When Should We Repair a Torn Rotator Cuff? Factors Predicting Reparability, Healing, and Clinical Success*

(**Click here for a PDF of Dr. Yian's Presentation**)

Dr. Yian: Alright, thanks Larry. We are fortunate to have some leaders here who really advanced this topic over the years. Hopefully this will segue into a discussion on their insights about this a bit later on. So we know that many rotator cuff tears are can be treated non-operatively, and certainly Jed Kuhn and the Moon Group have studied non-traumatic rotator cuff tears and found that 90% of these tears were effectively treated non-operatively (Dunn WR, Kuhn JE, Sanders R, An Q, Baumgarten KM, Bishop JY, Brophy RH, Carey JL, Harrell F, Holloway BG, Jones GL, Ma CB, Marx RG, McCarty EC, Poddar SK, Smith MV, Spencer EE, Vidal AF, Wolf BR, Wright RW; MOON Shoulder Group: 2013 Neer Award: predictors of failure of nonoperative treatment of chronic, symptomatic, full-thickness rotator cuff tears. J Shoulder Elbow Surg. 2016 Aug;25(8):1303-11); that means that we are only operating on 5-10% of rotator cuff tears. I think we can agree on a few basic tenants about cuff tears, including that they

cause pain, loss of motion and strength, but after surgery strength and pain can be improved with an intact cuff repair or with a re-tear. Certainly, re-tears can negatively affect clinical results, primarily with strength loss. Now with a structural failure rate of up to 30% and a minimum in some studies, who decides which tears should be repaired? Is it us? Is it the patient? Or perhaps in the future someone impartial observer or an algorithm? And do we even have enough information to make a decision about this based on all the factors in play? The question comes down to who we are operating on and why we are operating on these. There is no consensus in the literature, and this has been studied on a community level and on an international level as well and no absolute guidelines have been made. In the past, the indications were arbitrary or ambiguous at best. All appeared to be young patients, all full thickness tears, and all patients who failed non-operative treatment. But perhaps with recent literature we can develop refined indications for surgery and perhaps give our patients a more realistic expectation of what to expect after surgery at mid- and long-term outcomes. So what does the literature show us as far as non-operative versus operative treatment? Well there's only a few studies; and these all are all international, all small to medium size tears, and all short to mid-term follow-up. The problem with a lot of these studies, however, is that they lump acute with acute and chronic with chronic tears, and this can make it very difficult to draw practical conclusions based on these studies. One study showed on one and five year follow-up that operative treatments did better than non-operative treatments, but this did not meet minimum clinically important differences based on constant score. In fact, if we look at it a little bit more, the non-operative group had 40% progression of their tears more than 10-15 mm and this correlated negatively with outcomes compared with in the operative group, where only 13% had re-tears and they were all smaller than the original tear size. So perhaps this indicates that we are able to change the natural history to some extent in some of these tears.

What does the literature show us as far as clinical outcomes and factors associated with it after rotator cuff repair? Unfortunately, most of these studies are levels 3 and 4 evidence. As far as acute tears, the HSS group with Dr. Marx has shown in a systematic study that acute tears do better after treatment within three weeks from the time of injury as compared to those in which treatment is delayed more than three weeks after the injury. We know that with more severe weakness and more disability, patients will often have more negative clinical outcomes whether we treat these patients non-operatively or operatively. In addition, we know patient expectations play a role as far how they do with physical therapy, non-operatively as well as how they do after surgery.

How about pain? The literature is not at all robust as far as using pain as a major decision-making tool for the decision on which treatment is best for cuff tears. In fact, we know that pain is no different in patients who have re-tears versus intact cuff repairs, and also pain is not any different in patients with more severe tears or chronic tears as well.

Age certainly may not play a difference, and we know that older patients tend to have more degenerative tears which are more retracted. But we also know that older patients tend do very well, with 89% good outcomes after surgery for these tears, as Professor Gerber and others have shown in the older (65 and 70-year-olds) population

groups. This may be related to less motion and physical disabilities in the older patients compared to younger patients, though.

How about gender? There are two studies showing that female gender negatively effects clinical outcomes after cuff repair surgery. Why that is, we certainly do not know, but there are other studies that refute this as well. So, better research needs to be done on this topic.

What about tear size? Dr. Cofield published a landmark study 15 years ago, and he showed that tear size was the major factor as far as predicting patient satisfaction, and clinical outcomes and incidence of re-tear after surgery. We know that small-to-medium sized tears can do well in 89% of patients after surgery as compared to 30-50% of the time in massive tears. Perhaps we should consider repairing small-to-medium sized tears earlier before they get to large sized tears. However we need to identify which tears from this group are most likely to progress.

What about the factors that contribute to re-tear after cuff repair. The three most important that we have found: 1. Increased (older) patient age; 2. tear size; and 3. fatty infiltration of the supraspinatus muscle. There may be other factors. For example, Professor Gerber has suggested that a large critical shoulder angle plays a role in evolution of rotator cuff tears and in their healing. A recent Korean study showed that muscle atrophy (occupation ratio of the supraspinatus muscle), as well as retraction of the rotator cuff were the two most important factors that lead to re-tears in their group. Professor Gerber's group showed that tendon length and Goutallier score (Fatty atrophy) were the two most important factors that led to higher re-tear rates as well. The problem with a lot of these studies, however, is that they don't have large sample sizes with uniform treatment arms that carry the statistical power in order to be able to give us more definitive statistical conclusions based on the questions in play.

How about visualizing the tendon, and this something that Paul Sethi looked at last year and showed that, by visualizing arthroscopically what the tendon looks like, he could not correlate that with histologic-grade, clinical outcomes or re-tears. So, perhaps we should be repairing these tears despite the clinical appearance of these tendons inter-operatively.

Footprint coverage (surface area contact) probably makes a difference. Transosseous technique has been shown to have higher healing rates in the massive to large tear population compared to single row. And delamination has been shown to have a nine times higher risk of re-tears. Tear patterns may play a role, and there are other studies, including one by Bruce Miller from Michigan, that have refuted this.

Dr. Carr from the UK did a large multicenter, study recently showing 1-year re-tear rates with MRI, and he found that age was the most critical factor that determined re-tear risk. Now, once he controlled for age, the only other factor that was associated with re-tears was massive rotator cuff tear size. He did note that he had 34% re-tear rate in the

small cuff repair population; this highlights his conclusion that we need better strategies and techniques to get these tendons to heal.

Intrinsic factors of the patient play a role as well. Diabetes in an international study had 2.5 times higher risk of re-tear; dyslipidemia led to a 53 times higher risk, and this is defined as cholesterol higher than 240. There are also studies showing increasing BMI and more bone mineral density play a role as well with re-tear risk. However, we do not know everything about this as well. In basic science studies, smoking and diabetes seem to decrease healing rates, but this is not translated to clinical reality when we look at re-tear rates after surgery in which some studies have shown no increased risk of re-tear when we look back at the cuff repair population that has been operated on. Statins have been shown to increase healing in an animal model, and decrease revision risk in multicenter studies; however, we do not know the effects of given statins or even doxycycline, which can improve tendon healing in animal models. We do not if that translates on a human level as well.

And lastly, what about re-tears? We like to believe that all re-tears do well after surgery, but, as the Washington University group showed, 50% had negative outcomes in the setting of a re-tear after surgery; this was linked to occupations where heavy labor was the job activity, more activity levels, and a higher self-perceived functional baseline status. Professor Gerber also showed that fatty infiltration of the subscapularis and infraspinatus muscles, as well as increases in remnant tear size negatively correlated with outcomes after a re-tear. So, as an *Arthroscopy* Editorial Commentary comments on, there still remains a large gap between what the scientific literature has for us and what the evidence tells us on when we should repair rotator cuff tears. Until we have better scientific literature, perhaps even future ideas like risk calculators or predictive algorithms, probably won't be as helpful for our patients. Thank you.

DISCUSSION

Dr. Gulotta: Thanks Ed, that was great. So now we are going to do a mini-debate here between Bassem Elhassan and Eric Wagner. Bassem is going to talk to us about arthroscopically-assisted lower trapezius transfer.

Dr. Elhassan: Thank you so much. Meanwhile, Gilles I want to ask you: in your opinion, how do you define a rotator cuff to be irreparable? When a patient is coming to you, and you look at them and the exam; let's say someone is coming for an exam, in their 50s or 40s, and he has a massive rotator cuff tear, and when do you say, "Well, for me this is irreparable?"

Dr. Walch: I do not use this word "irreparable" because I don't know what it means. You can always close a tendon tear; you can do a superior capsular reconstruction. So what is irreparable? I don't know, for me, what I know, is that if there is fatty infiltration, level 3 or 4, whatever you do, doesn't work. And you will never restore good muscle. So instead of thinking about irreparable rotator cuff tear, we should think about complete fatty infiltration of the muscle, because this is really the problem. To repair the bone in the cuff is not a big deal, it is possible and it is not irreparable; it is always possible. But we cannot reverse the fatty infiltration. So, I don't know what is irreparable.

Bassem Elhassan: Arthroscopically-assisted Lower Trapezius Transfer

(**Click here for a PDF of Dr. Elhassan's Presentation**)

Dr. Elhassan: Awesome. So, I think this is part of the definition, in my opinion, because it involves whether it will heal or not. So, for me, because I do a lot of tendon transfers.

Why tendon transfer? Biomechanically you need the rotator cuff to hold the humeral head in place. Biomechanically you need these forces to hold the humerus down to be able to function. If you have a massive rotator cuff tear, everyone knows why pseudo-paralysis happens because now the humerus loses its constraint and instead of the deltoid being flexor it becomes an adductor and this causes proximal migration of the humeral head. The power of the rotator cuff muscles is essential to maintain the motion and strength of the shoulder. Now, there are things that show logic anatomically and physiologically, but there are others that don't show logic. Why? Everyone in this room has been in a situation where they see a patient, you look at them and cannot believe this is the same patient, with a massive rotator cuff tear and they can lift their arm all the way up. And then you see someone who only has a supraspinatus tear and can barely lift their

arm up 60 degrees. These are odd but when we talk about logic and as orthopedic surgeons we're sticklers for anatomy and mechanics so the power of it is very important.

Just to prove it, this patient has no deltoid. Zero. But he has normal rotator cuff and look at his motion and this is again someone in a small subset of patients because most of these patients have fatigue but this is his exam [motions to presentation]. He's pretty strong. If you want an exam specific for the deltoid, this is the exam I do sometimes. When you do abduction and internal rotation, his arm is going to drop down because he cannot maintain it. But why? This is something we're going to study when you want to keep the supraspinatus and the reverse shoulder arthroplasty. Because in this position, you are putting the supraspinatus vector completely anterior. It does not abduct anymore and drops the arm down. So if you don't have a deltoid to cover it, to mask it, you'll be able to uncover it this way. This is one way to do it. The is the same way as when you ask a patient to do an extension and they are slightly bent over and one arm drops down, even though he has full motion, one arm will stay slightly up. In this case, the deltoid has some function in it.

This patient has sarcoma and has had full excision of the deltoid. She has essentially full function except internal rotation mostly from stiffness. As you can see, there is nothing and she still has full function. This is how important rotator cuffs are.

I love this study done by Christian Gerber that was published in 2007. He injected the suprascapular nerve periodically and they used ultrasound; it was an EMG study. What they found? Most patients experience significant loss of range of motion of the shoulder in abduction and external rotation. He even called it pseudo-paralysis. The main reason I mention this is because, again, these patients have the best superior capsule you can ever have, this is the one that God gave you, this is the best one. And just when you paralyze the muscle that holds the rotator cuff and the humerus in place, they drop the function down. So this as a concept is not at all against SCR, but at the same time, talking about logic and biomechanics, because 80% of the patients that they enrolled were between the age of 20 and 30, they drop the function down to half or less. So for this reason, and whether this is the answer or not, and again I cannot confirm to certainty, but I feel that if we try to replicate or try to reconstruct the rotator cuff and replicate the line of pull and the power of the rotator cuff in one way or another, it may give us a better option to restore function.

Now among these transfers, which include teres minor, latissimus, and lower trapezius, I mentioned very often in this meeting and other meetings: why do we favor the lower trapezius? As we showed in a previous live demonstration, once you do a transfer and you try to rotate the shoulder, you can see how the rotator pieces move like a rotator cuff, you go in and out with the rotation. So the line of pull is really very duplicate of the infraspinatus. Second, I get this question very often, you don't have to have a biofeedback, you don't have to have the J maneuver to try to get the shoulder in abduction for flexion like latissimus because external rotation essentially withdraws the trapezius; whenever external rotation reflects, the rotator pieces fire spontaneously. And the third is the biomechanics study that we did and showed that the moment arm of external rotation with arm to the side is much better for the lower trapezius compared to

lattisimus, compared to teres major. And this has been replicated by other studies about the kinematics.

Now based on everything mentioned, what are cases in my opinion, that are the best indications for this or that. For SCR, isolated irreparable supraspinatus tear, massive posterior-superior rotator cuff tear with repairable infraspinatus tear that has no fatty atrophy (so someone who has an infraspinatus that's not fat or white), and those with intact subscapularis or reparable rotator cuff.

Now what are the best indications for lower trapezius transfer? These are cases where you cannot use anything else, like for example, brachial plexus you cannot use lattisumus or anything else because no deltoid and you try to use anything opposite the line of pull you're going to dislocate the shoulder down. So you use a transfer along the same line of pull as the humerus to get an external rotation. The second, and this is the one that Gilles talked about yesterday. These are the patients that were 30% of his population, did not do very well. 70% did very well with therapy. Those who did surgery did not see a difference, as I understood from his papers. There are a number of patients that are miserable and they get referred to my clinic and are absolutely unhappy. They come to me and are depressed, in pain (I have no idea why, it may be a different pathology), and have very limited motion. For this one, it is an ideal indication and the other indication also is if you have an isolated infraspinatus atrophy from suprascapular nerve injury, cyst, chronic cyst by the way. Like the one JP talked about today, when you have the muscle is fat, you will decompress the nerve and the nerve doesn't recover. There is a certain limit where you can decompress the nerve and the nerve recovers but certain patients won't recover. And for us also the posterior superior rotator cuff tear and this we have to prove it over time. And for the technique we started with open but now we almost always for the past several years we have been doing arthroscopic and this is again very simple. Essentially, find the lower trapezius between the medial border of the scapula and the medial spine of the scapula, dissect it out, prepare the allograft, attach it and distribute the thin portion with the shoulder abduction external rotation with the graft inside the lower trapezius and tied to itself.

Yesterday I also showed in the demonstration, if you do a vertical incision, when you are ready to do the attachment, the attachment is somewhere here. By the time you take the tendon and weave it in, the suture will be here. This is why it is easier to do it, for example, incision with arthroscopic technique. This is a fluffy patient, and we talked about the fluffy classification, he's fluffy 3 or 4, so I'm just showing here that in a fluffy patient you can do it but there are a few tricks, like anything else. When you do the same angle, the same triangle which is mediaspinal of the scapula and medial border of the scapula when you do the incision there is a layer of fat that you have to remove, if you don't take it out you well get confused. You will start to dig and you dig inside the tendon where you will get even more confused. This layer of fat you have to get it out. Once you get it out on the surface of the tendon, you find the tendon and the surgery is over. Once you find the lateral border, it's done. All you have to is detach it from the spine of the scapula. This is in patients who are fat. Patients who do not have much fat, it's very easy because you get into the skin and you find the tendon. Also in the

demonstration, yesterday, we showed that once you cut and detach from the spine and you stay superficial, there is nothing to worry about because the nerve is deep. If you want to see the nerve of course you can dissect it, I do it for the sake of my fellows to show them but most of the time you don't have to see the nerve. Once you reflect it, you can see the tendon; it's a very nice tendon and usually triangular and you can see it on the surface much much better. I put suture in it here mostly because when I weave the tendon I want to make sure the bottom of the tendon will not rip when I do the weaving of the tendon. So you put the suture and just now you search and you're ready and prepare the graft and the attachment of the graft. And this is an allograft. Again as we showed yesterday in the demonstration. This is a very simple part. Usually I use two Swivel locks and sometimes I add one medial anchor with a lateral row just to make sure. Most of the time you don't have to but because you already have these two sutures in. For this part, I get asked about it often, whenever you do—for this one you are done with the surgery right now. So you put the shoulder in abduction external rotation for the tension of the transfer. Once you put it in this position, you take the thin portion of the graft and you weave the tendon inside the allograft inside the musculotendon. So now if you want to pull this is protected. This is not going to rip. And if you move the shoulder after you can see how the muscle is moving like an infraspinatus muscle essentially.

This is another patient who insisted I do a tendon transfer even though she had Hamada grade 3 arthritis. I was going to do a reverse on her but she refused. I advised her and after three years this is what the tendon looks like. Look at the line of pull. It looks like an infraspinatus. We took a biopsy and we found a vascularized tendon with a fibroblast. I took it from 3 different locations. The outcome is really predictable in a lot of patients even with patients with complete or pseudo-paralysis. Some patients I don't do any repair of the rotator cuff, I just do the transfer and get out. This is just to show that I didn't do any type of repair. One of my patients is 30/35, a hardworking farmer, and even though he is a fluffy grade 3 or 4, he did very very well. External rotation strengths? You can almost guarantee that you will get it back; not completely normal, but close. Flexion is variable, but you can get external rotation.

For patient with musculotendinous tear, it is a whole other surgery. We have not published about them, but I have excellent outcomes for the musculotendinous tear. This is a patient who is a fluffy 3.5 or 4 and he had a bilateral. The left, he's still doing well. This is a year after the first one on the right side and then now you can see he cannot elevate the left side anymore and then he's only 6 months after the left side and he's still recovering but you can see his function: he has good external rotation. Again, I can show you a lot of videos, but we have very good outcomes with these patients. We published about the open technique with very good results and we are in the process to publish about the arthroscopic technique as well with very promising results.

Most of you probably know about the tendon transfer course, we run it every two years here, and Joaquin will be there April 25th-27th. And by the way this is Eric Wagner when he was an intern. He looks like a baby. Thank you very much.

Dr. Gulotta: Alright, thank you very much Bassem. So now we are going to have Eric Wagner who is going to tell us what the data shows comparing latissimus dorsi, lower trap, and superior capsular reconstruction. While that's getting loaded up, Bassem, what are your thoughts about doing this in conjunction with a reverse shoulder replacement.

Dr. Elhassan: I get asked this question often. Is it primary? No way, no reason. Because why would you add another incision. And, the most important thing that everyone knows is that reverse is not the shoulder; reverse is a constrained construct. So, whatever principles apply to a massive rotator cuff tear with tendon transfer might be able to change in the setting of a reverse. So latissimus will still work; it will not give you great outcomes. Gilles Walch talked about this and I really liked what he said. In many patients who still have a functioning teres minor, they have a latissimus transfer and do well. As far as external rotation, proximal migration changes the moment arm of the teres minor, so they have some ER. And if you add latissimus transfer they get better external rotation. If a patient has complete absence of the posterior cuff including the teres minor, they barely get to neutral rotation after a latissimus transfer. Can you justify the lower trapezius, as it might be better? I cannot justify a latissimus. In the revision setting, if I have a patient who comes back, I will offer both, and usually I would be more willing to do the lower trapezius.

Dr. Gulotta: While we are on the topic of reverse replacement with marked ER weakness, do you do only latissimus or latissimus plus teres major transfer?

Dr. Elhassan: I am sorry, but absolutely latissimus only, and I can talk about this over and over. Because if they lose internal rotation, they are miserable, they are unhappy. I had a patient who came last week, from one of my partners, and they did a reverse on both shoulders. She was telling me something I did not know. JP was talking about outcomes: this patient, she could not cut her steak. I did not know that this motion [gestures cutting motion], requires internal rotation strength. I honestly did not know it. She is telling me "I cannot cut my meats." I was thinking about it as I was examining her. Some people ignore the subscapularis, and they have to go through the pectorals major instead of the internal rotator; if they go through the latissimus and teres major, where is the internal rotation coming from? So, I would like as much as possible to spare the teres major.

Dr. Gulotta: And with that, let's talk about the data. Eric….

Eric Wagner: LD vs. LT vs. SCR- what are the differences in outcome?

(Click here for a PDF of Dr. Wagner's Presentation)

Dr. Wagner: Thank you very much. First I would like to thank my mentors: Dr. Sanchez, Dr. Elhassan, and Dr. Warner, who rode down in first class in JetBlue on the way here. I am thankful for the professional and personal advice that you have provided. So, the concept of irreparable rotator cuff tear was first introduced (or at least expanded upon) by Dr. Galatz and Dr. Lafosse with relatively high re-tear rates in these massive cuffs. There have been multiple considerations; some of them have stood the test of time, but there is a lot of debate as to how to actually treat these. The two topics that I am going to consider are the evidence for tendon transfer in such cases, and the humeral head elevation with superior capsular reconstruction. So what do we know about each? So first starting with the superior capsular reconstruction, the strategy behind this technique is to restore superior stability to the humeral head, re-center the humeral head, and provide a graft to augment the infraspinatus and the subscapularis. There is emerging evidence on the effectiveness of this technique. First, Dr. Mihata in Japan showed with his tensor fascia lata autograpft that there are very good clinical outcomes without any re-tears. Studies in the United States in recent years, with the first coming from Dr. Denard and Dr. Burkhart, showed good results with dermal allograft; yet their overall 68% success rate and 19% revision rate was less successful than what Mihata reported. So, their experience wasn't perfect and they offered multiple considerations when performing this procedure. Some of these considerations have been borne out through a variety of biomechanical studies. First, infraspinatus repair seems to impart better stability. Second, Graft thickness is important and 8 mm autografts seem to better than 4 mm autografts or allografts. Tokish brought up the idea of doing a partial rotator cuff repair, particularly with the infraspinatus.

We wanted to looked at our experience at the MGH with superior capsular reconstruction. There were 34 patients who underwent SCR over a 22-month period; the average age was 60 years, and 53% of them had prior rotator cuff repairs. There were a variety of concomitant procedures that were performed. Over 50% had infraspinatus Goutallier classifications of Fatty atrophy greater than Grade 2, and all of them had either Hamada 1 or 2 changes. There were a number of surgeons involved with varying degrees of experience with SCR. Our short-term outcomes demonstrated that these patients did not seem to improve overall in their clinical outcomes with regards to shoulder range of motion, pain, or subjective shoulder value at a mean follow-up of 12 months. There was a 24% re-operation rate, with a 1-year survival free of re-operation in 64% of patients. And most of the re-operations were either revision to reverse prosthesis or latissimus dorsi transfer. Using a modified Neer classification to classify as failure, we defined failure as either additional surgery or failure to meet a "satisfactory" outcome. Using this classification, there was a ***65% overall failure rate***. ***And at one year, the survival free of***

failure was 34%. We looked at a variety of factors that contributed to these outcomes. The first factor was the consideration of a learning curve. Since there were a number of surgeons with differing experience it was important to consider each might have been at different points on their learning curve. When we considered this we found that there was a 77% failure rate in the surgeon's first 10 cases. Moreover, there was 80% failure rate in patients who had a prior procedure. There was an 84% failure rate in patients who had Grade 2, 3, or 4 infraspinatus fatty infiltration. This demonstrates the learning curve when comparing the surgeon's first 10 cases to the second 10 cases (see ppt).

So now moving on to the tendon transfers and starting first with the latissimus dorsi tendon transfer. There is a fair amount of evidence behind the latissimus dorsi, Christian Gerber was the first to propose this solution. Numerous very good mid-term and long-term studies of the open procedure have demonstrated reliable outcomes. A variation among these studies is the location of the transfer: whether you do a modified l'episcopo as Dr. Boileau has championed, or transferring to the tuberosity through a posterior approach as Dr. Gerber has championed, the results are similar. Restoring external rotation is up for debate; I think your restoration of abduction (at least in these biomechanical studies) seems to point towards the greater tuberosity. Other negative prognostic factors include teres minor fatty atrophy > grade 2, revision setting, and subscapularis pathology. Gerber also demonstrated that those who had not only subscapularis and teres minor pathology but also critical angle shoulder angles greater than 36 degrees, had worse outcomes.

Dr. Iannotti showed that in some patients, poor outcomes after latissimus transfer were secondary to variable in-phase contraction as he demonstrated this on EMGs. Some patients simply could not activate the transfer during flexion and attempted ER. Recent advances that have really improved this technique have been the addition of arthroscopic techniques and this was championed by Drs. Keeny, Valente and LaFosse in France. At relatively short-term follow-up, all of these studies have shown very good clinical outcomes. In response to Dr. Iannotti's observation that some patients cannot activate their latissimus transfer, Dr. Warner has championed this idea of biofeedback, where the patients can potentially retrain their latissimus (which is an internal rotator) to become an external rotator using a relatively inexpensive therapy technique.

Dr. Elhassan covered most of the details of the technique of Lower Trapezius Transfer. As he mentioned, the lower trap transfer is in an in-phase, in-line transfer that does require a bridge allograft. In this way it differs from the latissimus dorsi transfer which is out-of-phase with its desired action once transferred. The Mayo experience of Elhassan has demonstrated good outcomes with the open technique of lower trapezius transfer and most recently arthroscopic-assisted techniques. So then the question is: which is the better transfer, latissimus or lower trapezius? Actually there is no data available in the literature which allows one to compare outcomes. So, using the Arthrex SOS registry system, we were able to review and compare out outcomes with both procedures and also compare these to SCR with global data available as well. We found there was an improved overall pain score at 12 months and this favored both tendon transfers over SCR. However, there was no difference in the ASES scores between

tendon transfers and SCR. And similarly, SSV (Subjective Shoulder Value) was also relatively equivalent when comparing the two techniques. One significant observation we made was that SCR when combined with a partial rotator cuff repair, was equivalent to an arthroscopic tendon transfer, whereas when SCR was performed without an associated partial repair of the cuff tendon transfer was superior. In fact, SCR when performed as an isolated procedure resulted in worse outcomes in every category after one year.

So which of the tendon transfers was better? Biomechanical study tends to suggest that the lower trap. Transfer restores external rotation better with the arm in adduction and the latissimus dorsi does this with the arm in abduction. Again, we used the Arthrex SOS registry system to review our results and to compare latissimus dorsi transfer one open as well as arthroscopically to lower trapezius transfer performed arthroscopically. We found that either the latissimus or the lower trapezius transfers performed arthroscopically resulted in significantly less pain than the open method of latissimus transfer. There was, however, no difference between either transfer when performed arthroscopically.

So what can we conclude from this work? First, SCR is an evolving technique and learning curve is an important factor. When combined with a partial repair of the rotator cuff it yields results similar to arthroscopic tendon transfer. We probably don't yet understand which patient is ideally suited for which procedure. Second, arthroscopic tendon transfer offers a process of recovery which is significantly less painful than an open approach. Third, as this is a debate with Dr. Elhassan, it appears there is no evidence that one transfer is better than the other notwithstanding that the latissimus is an out-of-phase transfer and the lower trapezius is an in-phase transfer.

Discussion:

Dr. Gulotta: Nice work Eric. I think what is lost in a lot of this is that these are salvage procedures where other surgery has already failed. The priority procedure is to try to repair the rotator cuff, and this is when that ship has already sailed, so what can you do to salvage the situation? Can you put dead skin in there? Can you transfer muscles that aren't supposed to do these things to do it? I think you see that it kind of gets worn out in the data. Larry (Dr. Higgins), do you have any comments about the study that was presented about the MGH experience with SCR?

Dr. Higgins: I do think that it's interesting to go back and look at a subset of patients in the learning curve. I think early on, the attention on the subscapularis was probably not the focus, and there was certainly one member of the surgeons performing this procedure who appeared to be agnostic to the of the status of the subscapularis during his SCRs. Of interest is that I participated in the Orthospace balloon study which randomized patients

to the balloon or partial rotator cuff repair. I observed that I chose patients that were going to participate in that study who I believed would never have been candidates for a primary partial repair. And if I thought that they were going to be good candidates for that, I would have engaged them only to do that. We had 17 cases, and I can tell you that my partial repairs did remarkably well, and I was very surprised. I think Bassem commented on this, but when you do an SCR, you need to do an infraspinatus repair; and I think that if you do that, then it is a very different operation than if you just do an SCR without a partial repair. I think that is the key to that operation. Also, if you do an SCR in a patient with a subscapularis tear and this is a Type I tear, I would absolutely fix a Type I tear in that case, and I would often take the graft and include it in the subscapularis repair. So I think that if you change that procedure, then I think SCR is not just an SCR now, it is an ***SCR plus***. If you look at the data, and Eric and I talked about this today, the best pain relief, and the best functional group was that group. It was better than our tendon transfers, and it wasn't statistically significant, but it was in a group of patients that we did an SCR with a combined repair. I think that we are still learning, but I think that's been the big evolution in my thoughts about SCR.

Gilles Walch: Reverse for Irreparable Cuff-Pearls to Optimize Outcome

(**Click here for a PDF of Dr. Walch's Presentation**)

Dr. Walch: Thank you. This talk has nothing to do with the massive rotator cuff tear and the problem of active external rotation, so I apologize if I missed that. I have a strong conflict of interest behind this talk of course. So for reverse shoulder arthroplasty, we used to say that we had three problems. First, the rate of complication; second, the rate of notching; third, the loss of internal rotation. We basically solved the problem of complications, so ***we are left with two problems***. ***The rate of notching increases in severity and in frequency with time. The second problem is the limitation of internal rotation***. So, with this talk, I will try to address the first problem: how to avoid notching. I think that internal rotation is another problem, and I know that Larry will discuss this later on. ***So, notching is a concern, and notching leads to biological reactions and to secondary osteolysis.*** And there is as strong correlation between this osteolysis and the grade of notching. We also observe a correlation with resorption of the tuberosity; even though it is after 10 years, it may be a concern if there is still some teres minor attached because we lose another rotator cuff muscle. So we analyze the influencing factor, and ***clearly the position of the sphere with regard to the inferior part of the glenoid is crucial.*** The sphere should always be low or very low with regard to the scapula in order to limit the rate of notching. Also, you can use the eccentric sphere to increase this inferior overhang. Also, lateralization is important; it has proven that when you do this kind of lateralization, either with metallic lateralization or with biologic lateralization like Pascal Boileau, you lower the rate of notching but you do not completely avoid notching. ***It is important to understand that notching is related to friction; it is not abutment.*** In other words, in abduction you do not have notching by contact; ***notching is the result of friction between the polyethylene and the scapular pillar***, ***which occurs basically during extension of the arm and when you walk, or during internal and external rotation.*** Abutment limits your range of motion, so it is a limitation of your rotation. But

friction leads to notching on both sides, on the scapular side and also on the polyethylene side. So what we have avoid is this phenomenon during extension and external rotation if we want to avoid the notching. So, we have to avoid contact during extension and external rotation if we want to avoid notching. So, in order not achieve that, there are some golden rules. First, you need to lower down your sphere as much as you can. You need to lateralize your sphere as much as you can. You also need to lower the neck shaft angle, starting from 155 to 135 degrees. So, all three of these tools are useful to avoid notching. One is not enough; two, maybe enough, but it is better to go with the three of them. So according to your philosophy, I would say to your religion: if you do not like to use, for example, 135 degrees neck shaft angle, you have to play with lateralization and inferiorization. If you do not like to use the eccentric sphere because it is not your religion, you have to play with the neck shaft angle and the lateralization. So, according to your religion, you have to play differently with those factors.

Glenoid inferiorization: so it can vary between 3 and 10 mm according to the size of the baseplate you use and the size of the sphere; if you use an eccentric sphere you cannot do a 4 mm inferiorization, up to 10 mm total to avoid this contact during extension with the posterior pillar and during external rotation. Glenoid lateralization, at the beginning, I have to recognize that I was strongly against that, I was afraid about glenoid loosening, but Mark Frankle was the first one to say, "Well, it is not a problem." He was the first one to lateralize 10 mm at the glenoid center of rotation, and he was right. Then, everybody froze, and said "Wait," and now we see that this lateralization may be through the sphere or through the baseplate. But, 5-10 mm lateralization of the center of rotation seems to be good and it is typically accepted; it is good to avoid this contact during extension. It can also be a biological lateralization according to Pascale Boileau, and for that, everyone agrees on 10 mm. But, this 10 mm lateralization is not always possible because sometimes you have secondary erosion of your glenoid, and in those cases you cannot anchor correctly the peg inside the bone. So, there are some challenges to this glenoid lateralization; 5-10 mm is not always passible, and it depends on the glenoid bone start. So that also is a limit to use glenoid lateralization to avoid notching. Lower the neck shaft angle, so we started with 155 degrees with Grammont prosthesis, and everybody was afraid to change because we were afraid of instability using 135 or 145. Now, the data and the literature are here to prove that 135 does not lead to more instability. So, we can play with the neck shaft angle in order to avoid notching. So, the golden rules to avoid peripheral impingement and mainly notching (because this is our concern): inferiorization, refers to the positioning of the baseplate, flushing with the inferior part of the glenoid, and the eccentric sphere; lateralization, ideal lateralization is if you start from normal glenoid, it is probably 6 mm and no more otherwise it is very difficult to reduce (however, if you have previous erosion of the glenoid, 5-10 mm is safe with regard to glenoid anchorage); and neck shaft angle, the debate is open because some people prefer to use 145 degrees, and others use 135. It seems that 135 is very useful to avoid this contact. So, this was the example, but I think it was just to show you that we can play with inferiorization, lateralization, and neck shaft angle in order to avoid contact in extension and during external rotation. I think that we are short on time, and this is not really useful. Thank you.

Discussion:

Dr. Gulotta: Are there any question? Do we have any time for discussion?

Dr. Yian: How do you adjust soft tissue tension when you lateralizing or inferiorizing your baseplate? It seems like it's always stiffer, and when you are trying to put in a 42 glenosphere it is always very difficult to get it to reduce.

Dr. Walch: Soft tissue tension is a problem. I do not have a great answer for that. I use typically a 36 or 39 for the ladies: if the baseplate is 25 I use 36, if the baseplate is 29, I use 39. For men, I use basically 29 as a baseplate and always 42. Regarding lengthening or lateralization, we need to lateralize the glenoid for sure to avoid notching and to improve the rotation, so I would love to use all of the potential lateralization in the glenoid, 5-10 mm, and try to reduce the uni-lateralization as much as I can. That is for lateralization. Regarding lengthening, we understood that lengthening is more important than tension because tension is subjective and something that we cannot measure, that we cannot compare, that we cannot assess, whereas the lengthening you achieve is correlated to the lengthening of the deltoid, therefore the tension. So, we rely more on the lengthening and the end is to achieve between 2 and 3 cm of lengthening compared to the other side.

Dr. Elhassan: You started the first slide by talking about internal rotation and you talked about everything, but I did not get the answer from you. So, in your patients, can you predict post-op internal rotation…

Dr. Warner: We are going to talk about this (Internal rotation). Let me just make one additional comment: even now I've been working with Gilles and Pascale and when we look at how we plan because we use virtual planning, we don't plan the same. And so we share this, and when we can't agree, I ask myself: "Then how do we reliably improve the approach of individuals that may be using this?" Should they use Gilles's approach, my approach, or Pascale's approach, and even now the engineers for this planning tool (Blueprint®) are working on an artificial neural network known as machine learning, with the plan being to optimize positioning. But positioning according to who? And this is really a difficult decision, because in the end, none of this provides value unless it can consistently achieve the same aim. And that means that if he does it one way, I do it another way, Pascale does it another way, I don't want to wait 10 years to see who has less notching, because that is going to affect the ultimate durability of the outcome. So, this is something that we can still not agree on, and that needs to be worked on. Hopefully through AR and machine learning, we can create an approach where you engineer it so that people cannot make errors, which is really the most important thing.

Dr. Singh: Besides medialization of the glenoid, what else do you take into account?

Dr. Walch: Lateralization of the glenoid?

Dr. Singh: Yes, but the medialization of the glenoid wear, do you take into account the acromial coverage at all? Because, you know we had all of these ideas about the acromion size also making a difference, so would that make sense? Should we take that into account?

Dr. Walch: No because glenoid lateralization/medialization results from erosion. The goal is to restore the joint line as much as you can. If you have enough bone, you can lateralize at least 10 mm, 15 mm maybe. But the problem is more the glenoid than the acromion; the acromion does not change anything. Did I answer your question, or was it something different?

Dr. Singh: Well it would make a difference, I don't know about the coverage, if you have a really big overhang.

Dr. Walch: What does it change?

Dr. Singh: Your bone length, the moment arm.

Dr. Walch: Yes, but what does it change, in your technique? Any way you try to lateralize your glenoid, the threshold to lateralize your glenoid is not the acromion. You always try to do as much as you can, but you have the glenoid anchorage which is the limit, I think.

Dr. Gulotta: I am curious to see what people in the room think about this case. I think this is a pretty good example of a number of different options. So, Gilles, a 45-year-old man, probably with an irreparable rotator cuff; I would say forget about non-op treatment because he is a candidate for surgery. So what surgery?

Dr. Walch: 45 years old? Very young. From what I see, it is fatty infiltration Grade 4. You cannot tell on the left, but on the right side it seems to be at least 3 or 4. But the teres minor is excellent, so I know that the patient will have excellent function and external rotation, thanks to the teres minor. He has a good subscapularis. The only problem will be the strength and the elevation, but as far his muscle, what's gone is gone. And even though you can do a latissimus dorsi transfer, you will not improve strength or elevation, in my experience. So, for this patient, I would do a partial repair because maybe there is something to repair with the infraspinatus, and a tenodesis of the biceps; that would be fine.

Dr. Warner: So, it's really interesting. This was by far the most effective approach, what you just said. But we can add an allograft, and that would be more expensive. We could do no allograft, we could take more time. I'm just trying to remember this case. He had no external rotation lag sign, just weakness?

Dr. Gulotta: No, he has a lag sign; minus 10 after.

Dr. Warner: So minor. And he couldn't fully raise his arms, just one finger?

Dr. Gulotta: One finger, yeah.

Dr. Warner: Well I mean we have no prospective randomized studies of what Gilles just said, and what I or Bassem may do with a tendon transfer. That's a worthwhile study that we need. One of the things that I think we are going to talk about at the business meeting is a multicenter study looking at massive rotator cuff tears in sufficient numbers to determine if there really is a difference here. And then if we analyze that according to the resources we used to get there, we will know where the value is in what we do. But right now we squander value everywhere based on our ego, our perception that one thing is better than another. And that frankly includes SCR, which is probably one of the most expensive solutions. So, I don't really know. What I would do here for this patient is a tendon transfer.

Dr. Gulotta: Latissimus or lower trap?

Dr. Warner: Well as Eric showed, there doesn't seem to be much of a difference, even though Bassem is very zealous in a religious way about the lower trapezius transfer. That is the way I look at it right now; that could change tomorrow. For me, having done a lot of these, the hardest part about latissimus transfers is just to harvest the latissimus. In a thin person, it is not hard; it's fast. And then when I've done that, I am done. Then I just transfer it, and fix it, and I am done. The hardest part about the lower trapezius is you fiddle around with the graft, it takes time to graft, it costs money, and frankly the way I look at is: if it's a thin person, it is pretty easy to do a latissimus. If it's a big person, "fluffy 3" according to Elhassan Classification, then the lower trapezius makes a lot of sense. So, it's a little like golf. Which club will I use, determines what I will do. And I really don't like to struggle with a big, heavy person with an arm like that. That's no fun.

Dr. Gulotta: So this one is a lower trap? Is that the answer?

Dr. Warner: This one is a big person?

Dr. Gulotta: Yes. He is a 45-year-old, pretty healthy big man.

Dr. Warner: Bigger than you?

Dr. Gulotta: Yes.

Dr. Warner: Then yes, I would probably do a lower trap.

Dr. Walch: If you would allow me, JP, I just want to tell you that you would never be able to do any kind of randomized study for that because everybody will sacrifice the biceps. And my assumption is that if have better range of motion after the surgery, if the patient is happy, it's because you removed the biceps.

Dr. Gulotta: So Gilles how can you predict that? Do you give them an injection beforehand to eliminate pain generators? Because really you are talking about pain inhibition for that patient, correct?

Dr. Walch: Yes.

Dr. Gulotta: So, is there something that you do that helps predict that?

Dr. Walch: Yes, you can do a cortisone injection or a cytokine injection, but I don't need that. I mean, you know that you have a good teres minor, a good subscapularis. Except, you are painful if you have the biceps.

Dr. Warner: I'm just confused. You said you would do a partial repair, why even bother?

Dr. Walch: Because if there is still some infraspinatus that you can repair, I cannot say today: "No, never repair that." There is some kind of muscle…

Dr. Gulotta: I wonder: if we do a larger convergence, is it an intra-position arthroplasty between the humeral head and the acromion? And that is really what we are talking about for a lot of these. I don't care if you put Vicryl, the balloon, in there, or if you put dead skin in there, or if you use autograft and put the patient's own tissue in there. They may all be acting pretty similarly.

Dr. Sanchez-Sotelo: So, JP, based on your data, have you abandoned SCR, or do you continue to explore it?

Dr. Warner: Well, you know the problem with our study was that we had 5 surgeons, and we are talking about a learning curve. Each of us is on a different portion of the learning curve. If one guy does one, it's very early on his learning curve? So, the reality is, what is the ethical part of it? If I do 5, then 10, then 15, then 20, then 30, and I'm not getting better, how many do I want to sacrifice for my learning curve to get better? Honestly I don't know. The ethical thing to do would be to do what the case study from Harvard Business School did with the Martini Klinic, which is a prostate cancer clinic where everybody is measured and if you have a complication rate above a certain number, you must be mentored or you are out. So, what we should really do is take the people who are good at it, and make sure that they mentor people early on so that the learning curve is not an ethical factor for the patient. But, we are not wired that way, we don't do that. So for me, I'm not so thrilled with the numbers that I should keep sacrificing patients for my learning curve.

Dr. Elhassan: JP I have a question for you and for Larry (Higgins) as well. At this meeting (SDSI), when SCR was presented, the impression was that it can reverse anterior-superior escape, that you reverse complete pseudo-paralysis. I really want to

make sure that it's clear this is not the case, because when you have someone coming to learn from this meeting and they are talking about reversal of anterior-superior escape (and Gilles Walch knows very well about anterior-superior escape), but not reversal of pseudo-paralysis, we are not talking anything about the repair of the rotator cuff. I think this is really important: what are we finding? What are we talking about?

Dr. Warner: Let me even make it worse for Larry (Higgins). This is a concept and it also a marketable product. And so the reality is: I remember a video that was made from Chris Adams (who is a wonderful person), and he showed how to do this in the lab, and then he is pushing up on the humerus saying, "See, it stays stable now. We've centered it." What about that? What is the marketing question here, and how do we approach that? You can comment on that.

Dr. Higgins: So is the question what is the marketing approach here? I think the first part of it is there is clearly a learning curve that we all undergo And some pretty nice work has been done recently looking at the position that the arm should be fixed in order to optimize the minimization of superior translation. So in the past, there was no standardization. Dr Lee showed that the arm should be somewhere between 30 and 40 degrees of abduction when secured. And he has pretty good biomechanical data that does limit superior translation. It's interesting, I've spent a lot of time thinking about this and I've done a fair number of lower trapezius transfers. I was intrigued by them, I thought my patients did very well. I thought it was a better operation in my hands than a latissimus; but, I'm also not so sure... I've always hooked the infraspinatus and I've always fixed it to the graft. And I'm not so sure what is being achieved by the lower trapezius transfer or an SCR plus where you are actually repairing that, but I don't think that they are that different in many cases. And I think that there is a commonality here. Personally I think that an arthroscopic latissimus…my impression, my feeling was that I had a higher learning curve, that it was outside of my learning curve. It was hard for me to learn that because I thought it was easier for me to do the lower trapezius. There's also a huge disconnect between these surgeons who the SCR is marketed to. Almost everyone in this room is an arthroplasty surgeon, and they are not marketing that operation towards the arthroplasty surgeon. The marketing strategy is it towards the sports surgeon who is taking care of the 45-year-old patient. It's the guy who has outpatient priorities, or is a pretty good rotator cuff surgeon but is probably not interested in becoming a very good arthroplasty surgeon because his practice is not aligned in that fashion. The reality is that I would have anyone in this room do any of these operation on me before I let someone from the outside who is doing their first or second or third one because all of the people here are committed to being introspective. I think, to add to what Gilles said, if we are ever going to get the answer, I don't think we can do a randomized, prospective study because the variability is so large, not only in the substrate (the patient), but also in our intrinsic ability and our intrinsic experience. If you were to ask me right now to randomize my patients with a latissimus or lower trapezius transfer, I can guarantee that my lower trapezius patients would be better. And it may be the case that, in your hands, the latissimus would be better than the lower trapezius because you have more experience in that. That makes a study of this nature extremely complicated. Well what isn't complicated is collecting the data and trying to look at it.

Session II: Shoulder Arthroplasty

Dr. Warner: So can everyone get a seat so that we can start. I think we are going to ramp up the debate here a little bit, and this should be kind of interesting. So, we are really making Gilles work. But then again, when you are in the dessert and you come to the oasis, you try to drink as much as you can because you'll be in the desert again soon. So, this session has to do with arthroplasty. Ron Navarro was supposed to moderate this but couldn't be here for a whole host of reasons, not the least of which being the gas leak in his home. We are going to talk about shoulder arthroplasty and we are going to start with a question that all of us are interested in: "How can we improve the durability of anatomical glenoid components?" Gilles is going to give us his thoughts on this.

Gilles Walch: How can we Improve Durability of Anatomic Glenoid Components?

(**Click here for a PDF of Dr. Walch's Presentation**)

Dr. Walch: Thank you JP. So again some disclosures. Glenoid replacement is a problem for everybody. We know that. after 10 years, more than 50% of our patients have glenoid loosening (radiological glenoid loosening), and it increases with time. All of the authors during the last years (10 years or 20 years) have tried to understand why, and there are some golden rules issued from the literature. We know that glenoid retroversion should not exceed 10 degrees. Regarding the seating; nobody knows really, but it seems that at least 80% is the minimum seating you should have. But it is also a fear that if you do an excessive reaming of the subchondral bone, there is nothing else to prevent the migration of your glenoid. Excessive glenoid superior inclination is also detrimental because it pushes superiorly, creating eccentric loading. Also preoperative HH subluxation may recur. So, the failure of glenoid bone and the recurrence of posterior instability are the main cause of glenoid loosening, radiological loosening.

This is an example with a secondary rotator cuff tear and upward migration of the humeral head (See ppt). Here is another example: you see that for 10 years, the results were not too bad; and after 10 years, we observe upward migration of the humeral head, eccentric loading, superior tilt of the head of the glenoid. This is another example showing that this is not a fatality; all of the glenoid did not get loose, and if you look at this patient (he is a very good friend of mine), I did a reverse on one side and an anatomic on the other side, and after 18 years follow-up, there is absolutely no loosening. Maybe he is fortunate, I don't know, but maybe also we kept the good subchondral bone, internal rotation was good, seating was good. That means that if we analyze carefully all of the factors, we should be able to improve the long-term results. So, the golden rules have been proposed; of course, they have been established after 2D measurements. Remember that all of our patients were analyzed with 2D measurements, either on the X-ray or the CT scan. Now with the 3D measurements, maybe those rules are different. What is sure? That 2D measurements are not reliable, either with X ray or CT scan, and this is because of the gantry angle. We now should rely more on…this is an example with a 2D measurement showing that the glenoid retroversion is 15 degrees and thanks to the 3D

measurements, now we know that the retroversion is probably more important than was assumed. We are not finally able to analyze the glenoid inclination for all of our patients. Remember that 5 years ago, nobody discussed glenoid superior inclination or glenoid inclination. Now we learn more about that and that is the reason why we discussed with JP earlier on that maybe glenoid inclination than critical shoulder angle. Well, we have to prove that, but it takes time. In order to have 3D measurements, we absolutely need to determine the scapular plane in order to establish a coordinate system, and that means that we need to have a 3D assessment. We also need to recognize our insufficiency. As a surgeon, we are not able to assess neither the retroversion nor the inclination of our patients intra-operatively. Nobody can tell: this is 20 degrees retroversion, 15 degrees of inclination. It is absolutely impossible. So if we do not measure that preoperatively, we won't be able to correctly analyze our results post-op. Also, the seating is something that is very important to assess intra-operatively. So if we want to improve anatomic glenoid durability, we need to have 3D preparative measurements of retroversion, inclination, and humeral head subluxation, and we need to improve our accuracy of positioning, reaming, and seating. So, thanks to Joe Iannotti, 15 years ago we started to understand that we need to do this, and we need to have a preparative tool to analyze or perform all of these measurements. Also, new tools available through all the companies allow you to do a virtual implantation, to select the correct prosthesis, and then you have some kind of patient-specific instrument in order to implant the prosthesis as you decide preoperatively.

So, the first step for all of the software available is to do the 3D measurements to assess retroversion, inclination, and humeral head subluxation. The second step is to do this virtual implantation on the software, on the computer; this means that you do the surgery before doing I am entering the OR. And you know exactly how much inclination, retroversion, and subluxation that you are able to correct, how much seating you can assess, and finally, once you know exactly the good positioning of our glenoid component, you can build some kind of guide that you will use intra-operatively to reproduce exactly the position you planned preoperatively. This is an example with a metallic guide that allows you to exactly match what you have to do; this is probably not that different from one company to another company. The key point is to do this 3D measurement, this virtual implantation and to make sure that you are able to respect the golden rules. Maybe these golden rules will change with the 3D measurements, but at least we know where we are, we know what we are doing, and we will be able to analyze what we can do. These patient-specific instruments are able to help you to respect the plan, the preparative planning. There is some variation regarding the version: 3.4 degrees in average and also in inclination. But we are far away from the 15 degrees of variability of the surgeon's eyes. So, these 3D measurements allow confidence for the surgeon; accuracy; and also, good execution. In conclusion, how to improve your ability, I think that we may improve the design of the prosthesis, preserving the subchondral bone as much as you can because it is a real structure to avoid migration or tilt. Mainly, we want to improve our technique of implantation. Don't believe that you are the best surgeon in the world and you are able to implant the prosthesis by eye correctly. I think we need to have the head of the new technology to do this.

Dr. Warner: So while Larry is getting set up, we can pose a question that Gilles can answer…well you can try to answer for me now while he is doing this. Do we have to wait 10 years, or how many years do we have to wait to know that when we do all of this extra work, it is actually delivering value? Or is there some other way that we can have insight into this sooner?

Dr. Walch: No, I would say that we have to wait for 10 years to prove that we are correct. We have to be honest…

Dr. Warner: No, I would disagree. There's a question of who is going to do it. I'll have Larry say something in a minute. With my way of thinking, and I don't know if others think this as well, but it's feasible to use RSA analysis the way Ian Trail did to look at glenoid loosening, and to simply ask the question if that's a historical control with a 66% movement of the glenoid component early on, and we do this, we should see, if someone is able to do that study, that we change that. That the components do not move early on, which is somewhat predictive of what will be durability. So I don't if anybody has this lab, Mayo Clinic…somebody. But somebody should do that study because it would give us the answer sooner. You have something to say Larry.

Dr. Higgins: I think this is fantastic for us to be thinking about…long term outcomes, and I fully ascribe to Christian Gerber's philosophy about doing the operation in your head before you do it on the patient…or do it on the computer before you do it in the patient. But I see maybe a bigger opportunity in aligning the surgeon with the operation as well. Many surgeons are never going to be become very expert at doing these plans, right? It is probably beyond their capability for the journeyman surgeon to do these plans.

It may very well be that what we will do is align the surgeon with the patient, and the patient with the surgeon, by doing this preoperative planning in a prescriptive way for them in the future. And that is probably the biggest thing that you can achieve in the short term because 10-year goals are aspirational, but if you could inform a surgeon that he is actually looking at a 28 degree retroverted glenoid with 15 degrees of inclination that is going to need a bone graft, we know those patients need a higher degree of specialization and expertise.

Dr. Walch: It is what we call "automatic planning," meaning that we will deliver that. But again, it depends on your religion. There are Jewish, there are Muslims, there are Catholics, there are Hindu…some prefer to play with neck shaft angle, others with glenoid lateralization, and others with inferiorization. So you cannot force a surgeon to accept your religion, or your philosophy. So it's more difficult to do the automatic planning because it depends on the sensibility, or the religion, of the surgeon. You understand what I mean?

Dr. Higgins: But I think that we will be able to develop gradations of patients that have higher risk for failure based upon…I mean there are many surgeons who don't get 3D plans. I mean, Jerry Williams does not get a CT plan on his shoulder arthroplasties, he doesn't think he needs it. Maybe Jerry doesn't need it, but I am telling you the guy who does three a year probably should have one. He is about to do a B2 totally shoulder arthroplasty on a 60-year-old and never see the glenoid, and now position the glenoid. I think it's about advising the surgeons and being prescriptive about what cases they may not be best served to do as well.

Dr. Savoie: So, how many of you in this room feel like you can really do a 28 degree retroverted glenoid and do the right thing and get a good result? However you like to do it. You get this patient in, and how many of you think you can take care of that patient and get a good result if you did an arthroplasty? So Mike you can't?

Dr. Freehill: Yeah I can.

Dr. Savoie: You didn't raise your hand. Because I would be amazed if you go into a room of surgeons and say, "You know, you may not be good enough to do this operation." Very few surgeons are going to say that. They are not going say that. So what you are saying is admirable but I go with Gilles. I don't care, they are not going to say, "I'm not going to do that operation." Why don't you develop something that makes them better able to do it, that's fine. But to say that, especially in our country, you are going to tell someone, "You know you just, you aren't good enough to do this." That is not going to happen.

Dr. Higgins: That's not what I said Buddy, and that's misrepresenting what I said. What I said is, you are going to have gradations and you are going to say: "Hey, this is a B2 glenoid that's going to need a bone graft." And then the surgeon can make a decision. I am not telling surgeons what they can and can't do, and I think it's misrepresenting that I would ever want to do that. I was saying: align the surgeon with the patient so that they know that they are about to do a really complex case. They are about to do a B3 glenoid, right? Or a C glenoid. And all of a sudden they may say, "Boy, that might be hard for me to do." And let the surgeon decide.

Dr. Savoie: That is probably where we disagree because I don't think that they are going to say that. I think they are going to say: "Well I can do this. Do it anyway, and then you'll get the revision."

Dr. Higgins: Well, we can suffer fools. I can't stop people from doing what they shouldn't do.

Dr. Warner: This is good. I like it, good heat in the back of the room. I don't feel so cold anymore. My other favorite Larry is going to present on the dilemma of internal rotation with reverse, which is something I think most of us have been struggling with. So let me just ask a question before we start: How many of you think that restoration of internal rotation is problematic with a reverse? How many of you think you know how to fix it? Alright, so hold on to that thought.

Larry Gulotta: How can we Predictably Improve Internal Rotation in Reverse?

(**Click here for a PDF of Dr. Gulotta's Presentation**)

Dr. Gulotta: Thank you very much. I was sitting down preparing this talk in the evening. My 10-year-old son comes up to me and says, "Dad, what are you doing." I said, "I'm doing this talk I don't know…I'm going to put a Michael Jordan picture in because I like Michael Jordan. What do you think about this slide? Should I tell everybody that I don't know." He goes, "No Dad I think you have a growth mindset and you have to say, 'I don't know yet.'" Maybe he is going to be the next Michael Porter or Kaplan. But I learned from him just like I learned from my mentors as well. And that's what these people say: "I don't know yet." I consider myself, like many people in the room, very fortunate to consider both of these people my mentors. On the right, that is actually in Gilles's family living room in 2010. We were very fortunate to be able to visit him. And that is at MGH when I was able to visit JP, so thank you very much for hosting me in December.

When we think about why patients do not predictably get back internal rotation after their reverse shoulder replacement, a lot of it has to do with patient anatomy and type of implant we choose. We heard a lot about that in terms of how it pertains to notching from Gilles earlier today, and I would say a lot of the things he talked about in terms of notching can also be extrapolated in terms of internal rotation, or rotation in general as well. There are obviously considerations on the glenosphere; again, implant

considerations and technique considerations, and also on the humerus as well. But then there are also these soft tissue considerations, like posterior capsule contractors and obviously the status of the subscapularis. When I start to think about the reasons why my patients don't get back internal rotation, I really lump it into what I call hard stops. I think hard stops are mostly related to impingements; impingement can either be intra-articular or extra-articular, and we are going to talk a little bit about that in a moment. But then there are also obviously soft stops. These are the patients that come in and I ask them: "Can you get your hand behind your back." And they say: "Of course I can get my hand behind my back," and they just kind of throw it behind their back and jimmy it up. "See? See this is good! I can get it up this high!" And you know it can be better because even if that subscapularis was there, it would be a little easier of a job.

What I think about too: ***What do patients care about?*** So what functional positions do patients care about? I think about: do they care about external rotation with their arm at their side? And I'd submit to you that they don't really care. I think that patients need to get to neutral in order to really be happy, and anything beyond that is gravy. I've never been sitting down, wanting to reach a pencil over to my right, and said "if only I could externally rotate my arm a little bit more I'd be able to get that pencil." Instead, I just turn my arm, turn my body, and reach to get that pencil. But they do care about external rotation with the arm and abduction. This is how they function to get their hand to their head, this is something that Constant taught us; it's one of the tenets of the Constant score. But I submit to you that when you talk about external rotation of the arm and abduction, it's really a soft tissue, power, muscular thing. This is not limited by any impingement because, if you take the arm and do a saw bones thing, they can just rotate 360 degrees. ***So then the question becomes, do they care about internal rotation with their arm down at their side, so adduction. The answer is most definitely yes, they do***. And you're by your side, a lot of that does have that hard stop and it's limited by impingement as Gilles showed us. We can look at this in the lab, and I think when we think about impingement we really think intra-articular impingement; ***we think about the internal rotation and we think about the humeral bearing the cup, coming around and hitting the anterior aspect of the glenoid. But actually when we've modeled this in the laboratory, we find a significant portion of impingement also comes from the greater tuberosity hitting the coracoid as well***. So, I think that has to be something that we consider in terms of limitations.

What is important to patients? ***The Mayo Clinic has looked up patient activities after reverse shoulder replacements, and you can see right here tied for second is being able to reach behind for hygiene or dressing; this is the number one complaint that patients wish they were able to do better.*** And when we looked up our activity levels after reverse shoulder replacement, we were specifically looking to see if they can go back to recreational activities, but we also asked them what was the number one thing they were complaining about or they wished they could do better. The number one thing was inability to get their hand behind their back. ***In our series, about 30% of our patients said that was a really functionally debilitating thing for them.*** There's probably more patients like the ones I described earlier today who maybe do it and manage with it, but again it's definitely sub-optimal. ***Edward McFarland at Johns Hopkins looked at***

patient ability to toilet and reports overall 20% had trouble with toileting. And at my practice every day that's the number one complaint I have, that patients wished they had that internal rotation to help them toilet.

So, why aren't they able to completely get back internal rotation? Well let's look at the glenosphere for a moment. I don't want to belabor this at all because it is stuff that Gilles talked about. Mark Frankle talked to us about the positioning and size of the implants, and we know that a bigger diameter gives you more arc of motion in terms of internal and external rotation. We can inferiorially offset the glenosphere to eliminate inferior impingement, that helps. We also know that laterally offsetting the bearing can also help create clearance to eliminate notching and allow for rotation. And again, as Christian Gerber warned us against in the introduction here, incremental studies that basically re-hash the same thing, I did that and it just confirmed exactly the same thing that Mark said. I think we all pretty much accept all that.

On the humeral side, there are considerations as well. In that Frankle paper as well, when he looked at neck shaft angles, inlay versus onlay, and humeral offset (the size and thickness of the head you use), ***the only thing that really predictably improved rotation was that neck shaft angle as Gilles talked about here today***. We looked at: well what version should you put it in. So this was a big debate, and I think this still is a big debate and something that we can maybe talk about in the discussion here as well. What we noticed was that it is a fixed bearing arc, and so by changing the retroversion you just change the arc of rotation. So, the more retroverted you put the humeral component, the more external rotation the patient gets at the expense of internal rotation, and ***the more relative anteversion (or less retroversion) you put it in, they can get back more internal rotation at the expense of external rotation***. But again, this is using mostly a soft saw bone's model here; when we plugged it into a more sophisticated shoulder modeling unit, we noticed that putting it in at 0 degrees anteversion was actually bad for providing a better moment arm for the teres minor. So, we think that maybe putting in some retroversion might help provide a better moment arm for the teres minor to be able to do the other position that you care about, which is abduction when you are in external rotation. ***We sort of came up with this thing: if you might internally rotate, you are probably better at zero, and if you want to externally rotate you are probably at more like 30º or 40º; so let's split the difference and say maybe you should put it in at about 20 degrees.*** But the reality of the situation is that there are no clinical studies to support how version affects your outcomes. Here is a study that compares those put in at less than 10 degrees of retroversion versus those who put in more than 20 degrees of retroversion; they had no differences in internal rotation. Here is another study. They compared zero of retroversion to 20 degrees. And while they came up with some statistical differences in terms of vertebral level or their ADL scores in terms of internal rotation, you see it's one vertebral level and it's a 1.5 versus a 2.1 for ADL. So, while maybe statistically significant, I'd submit to you that maybe this is not clinically relevant. Here's just going back to Mark Frankle's paper, looking at the implant factors in terms of a hierarchy of what's most predictive. He thinks that placement on the glenoid (***so our ability to place it low and get some inferior clearance) is the number one most predictive thing that can result in internal rotation***.)

What about the subscapularis? I think we all agree that the subscapularis is important for internal rotation. Sometimes it's not even present, sometimes, when it is present, it's difficult to repair. ***I think there are two good studies that show that patients that had subscapularis repairs had better active internal rotation.*** Even a second study confirmed whether or not it had healed using a sonograph, and healed subscapularis were able to provide better predictable active internal rotation. However, what the studies also show is that a repaired subscapularis can also limit your external rotation, and so…I know these guys like Tom Wright who talks about it being the horn blower creator every time he repairs it. And so I think that the jury is still out in terms of the optimal thing to do. In my own practice, what I do is: I try to repair it if it's healthy and available, but I don't go through heroic lengths to do so if it's under any tension.

We can go through all of these different things. I spend a lot of time with our engineers and do my basic science aspect of my career so far playing with these various models and what not to come up with these different factors. But the one thing that we realized is that whenever we input patient CAT scans into our models, there is significant patient variation and probably, at the end of the day, that's the number one reason why we are not able to re-create at least internal rotation in our patients. And so, I think right now there's a certain level of standards that we need to reach in terms of type of implant. I think we are all converging into the mean in terms of different design philosophies or implantation techniques, but now we are getting to the next level, and that is: how do we really improve function and make a non-anatomic arthroplasty work more like a normal or anatomic shoulder? It is a tall order, but I think that we are there as a field. The question becomes: do you put it in the same place for everyone? And the answer is probably not, and that is the whole idea: it's patient-specific instrumentation and pre-op planning. If you put in so that you maximize range of motion, you put it in to maximize range of motion for sports. This guy wants to golf, this guy wants to play tennis, this person wants to swim. Or do you put it in obviously to maximize fixation as well? Are you jeopardizing function for fixation, and what's the tradeoff for that? So I think that's really the future and how we are going to solve this problem. I think that a lot of these preop planning software are phenomenal. I do think this program (and I'm not just saying this because JP and Gilles are here) is the first to truly give an idea in terms of where your implant and predicting for that specific patient what a saw bones model will be able to provide in terms of impingement and free range of motion. I submit that the part that is missing from the equation is the muscles and the way that the muscles are being able to support it. This is something that we look at in our lab. This is a Newcastle shoulder model; not only can you input the CAT scan for patients that has the bony anatomy, but then you can also recreate the line of actions for whatever muscles they have present or muscles that they have absent. We've done a lot of work with that. So if you ask me how we are going to solve this problem in the future, I don't know what the answer is today, but I think that perhaps this might be the answer. So you have patient who is 69 years old, he had X-rays revealing osteoarthritis, some posterior subluxation of the humeral head, and a B2 glenoid. But then he had an MRI and you see that the teres minor is completely atrophied and maybe when you exam him you have to go so far as to do motion analysis to see if you have a horn blower sign when that elbow flies out. You can put all that information into a computer model, both their bony anatomy, the absent subscapularis,

the way that they lift up their arm there and the elbow flies out (that's a horn blower sign). And then you start the model of reverse shoulder replacement with the appropriate size and the appropriate position for that patient, and maybe you decide in this case that the patient may be get the best benefit from a latissimus dorsi transfer, or a lower trapezius transfer. Maybe then it can be put into a finite element model to see where your screws are going to be and how you can optimize your fixation for that patient. Come up with some way to be able to recreate your plan intra-operatively so that you end up with what you think is at least a perfectly positioned implant for that specific patient so that you can optimize their internal rotation and overall function. Thank you very much.

Please join us for the 2019 Codman Shoulder Meeting on June 22, 2019. More details will be forthcoming!