Prof. Edmund Y. S. Chao: time is limited, but enthusiasm is unlimited

Received: 27 November 2017; Accepted: 25 December 2017; Published: 29 December 2017.
doi: 10.21037/aoj.2017.12.03
View this article at: http://dx.doi.org/10.21037/aoj.2017.12.03

Expert introduction

Edmund Y. S. Chao, member of the American National Academy of Engineering, Emeritus Named Chair Professor at the Mayo Clinic & the Johns Hopkins University. Engaged in biomedical engineering and biomechanical education and the practical scientific research development of orthopedics for nearly half a century. Main Research Areas: fracture repair and internal and external fixation biomechanics; gait analysis, joint/limb function assessment and development of functional indices; limb-salvage and prosthesis design after bone tumor or severe traumatic injury; computer-aided joint osteotomy preoperative planning; pioneered in musculoskeletal graphic and computational models development, simulation of biomechanical analyses and results animation displays. Published more than 356 referred journals publication, more than 200 books chapters and periodicals, written and edited 6 reference books.

Editor's note

At the 12th International Congress of Chinese Orthopedic Association in Zhuhai, we were honored to invite Prof. Chao (*Figure 1*), who is the Emeritus Professor at the Mayo Clinic & the Johns Hopkins University, to have an interview with us, sharing his experience in the field of orthopaedic biomechanics.

Interview

AOJ: We learned that you have made significant contributions in the basic understanding of musculoskeletal joint mechanics and artificial joint replacement prostheses design and testing in the hip, knee and shoulder. Could you briefly introduce the related research work you have done or you are doing now?

Prof. Chao: First of all, I'm not doing anything now. I retired twice. What I am going to talk to you is what I have done in the past. Yes, I have been working in the hip, knee area related to joint replacement, but anatomical regions

Figure 1 Photo with Prof. Chao.

are far beyond that. For example, I had an orthopedic surgeon student, who wanted to design thumb prosthesis. I asked him, "Do you understand the mechanics of thumb?" "No, I know the anatomy." He said. I told him that if you don't know the mechanics, you have to go back. Then, his mater's thesis topic was to look at the biomechanics of thumb and structures, rather than design thumb prosthesis. So this is the underlining basics that everyone should understand before embarking on a new surgical technique. For reconstruction of musculoskeletal system, you must understand the biomechanics involved.

AOJ: In your opinion, is it difficult to determine rotational deformity? How about 3D deformity? Has it ever been well defined biomechanically?

Prof. Chao: The answer is no. It has never been well defined. People think that it was well defined, but I don't think that it is. The anatomical system in the human body, is far more complex than any of the human-made mechanism in the world. So you have to respect the difficulties before you start the effort and meet the challenges. We used reference axises, coordinate systems but we forgot that the anatomical system and landmarks vary from one person to another. The most important thing is when a patient's joints have been degenerated, traumatized, or having other

diseases, all these references are changed or lost. Then you have to come up with another way of defining the rotational deformity, the frontal plane deformity, or flexion contracture and so forth. This type of problem has never been seriously studied. We should do that rigorously in the future. We spent so much time and effort on molecular and genetic based science. We forgot about the very fundamental but solvable problems in biomechanics, which are so important in finding the practical solutions in orthopaedic problems.

AOJ: How do you understand the role of biomechanics in knee osteotomy?

Prof. Chao: I have worked in osteotomy for many years. The interesting thing about this particular problem is that the outcome will be so very important and practical clinically. For any problem, we have to start from a very simple way. In my early days, I was basically looking at the knee joint axes in two-dimensional plane and that approach was well received. We had to make an assumption that if you made two-dimensional corrections, that could eventually be applied to three-dimension. That was good enough for a while. But now, we have advanced science and technology. It is necessary that we go beyond that. The last question you have is how do we define rotational deformity. That would be a three-dimensional problem. A special symposium on knee osteotomy was designed and will be conducted in this COA on determining how basic biomechanics can help us to make osteotomy of the knee, or hip, or ankle, shoulder, elbow finally to spine more effective and reliable. This is why I call this osteotomy symposium the frontier of future orthopedics and only biomechanics can help us explore this frontier.

AOJ: What kind of development of biomedical engineering we could expect in the future?

Prof. Chao: I like this question very much. I think that this is the key issue of why I'm so anxious to use whatever energy I have left to emphasize to orthopedic surgeons how important it is to learn and use biomechanics and how essential it will be to nourish bright, talented engineers as team members. Among these engineers, I don't care what fields they had been educated. They should always be trained in the understanding of the structure and function of the musculoskeletal system. They have to learn anatomy, to learn surgery, and to see patients. The weakness of the majority of engineers in orthopedics is that they lack practical engineering experience. They have little experience of solving practical problems. There is no short-cut, and you have to learn and practice how to do the basics. They have to learn and appreciate all the basics about orthopedic surgery before they may try to solve practical problems.

AOJ: We learned that you studied agricultural engineering and then you changed to study applied mechanics and applied to human musculoskeletal system. Is there any difference between these two disciplines in your opinion?

Prof. Chao: No, not really. The definition of applied mechanics means you use mechanics to apply in any other field. Agriculture biomechanics, that was what I studied in my master's degree, was a serendipitous breakaway point for me to pay attention to human mechanics rather than animals and plants. Agriculture engineering, in my opinion, is another way of looking biomechanics, so agricultural engineering and biomechanics share some similarities.

AOJ: You have won many awards and honorable titles in the field. Which one you are most proud of?

Prof. Chao: In 1989, with many years of research and development work in the field of bone tumor, I assisted orthopedic oncologists worldwide who wanted to save the limb of patients with malignant bone tumor. They appreciated what I have done to their specialty, one of my closest colleague, a professor of orthopedics in University of Rennes, in France, recognized my unique contributions and nominated me to his university, the University of Rennes as the recipient of an endowed honorary doctor of medicine degree. The most impressive thing was the endowment ceremony, held in the most famous Cathedral of Saint-Malo, at the coast of Normandy. During the ceremony, many of my international colleagues, they brought their own honorary degree ornaments and gowns and the Cathedral organist played my favorite music, "Ode to Joy" in Beethoven's Symphony No. 9. I regarded it as the ultimate honor in my life as an engineer. I want to tell young biomedical engineers, if they work hard, they would achieve similar honor one day!

AOJ: What you would like to do in the upcoming years both in life and in work?

Prof. Chao: Life is work. I have way passed my active

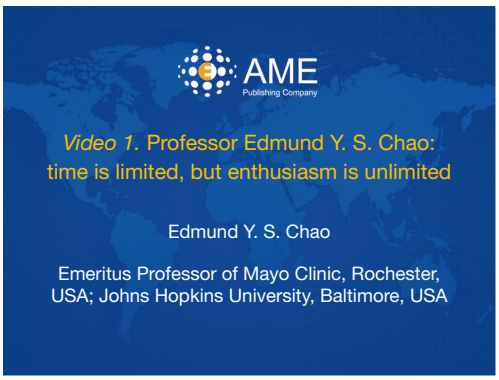

Figure 2 Professor Edmund Y. S. Chao: time is limited, but enthusiasm is unlimited (1).
Available online: http://www.asvide.com/articles/1904

professional life. But I could still work voluntarily for orthopaedic surgeons, nurses and engineers in education and mentoring. That is the most rewarding charitable work that would motivate most elders like me. I think that the young people give me the energy to go on. I want to educate and motivate young people as long as I could handle long-distance travel. But realistically, my time and energy will be very limited. So next year, I would like to organize an orthopedic biomechanics instructional course for the young engineers and surgeons. I will find the best teachers in orthopedics and engineering. Hopefully, that will help the field of biomechanics to rejuvenate to push orthopedics to a new level of value and excellence.

Let's enjoy the video (*Figure 2*)!

Acknowledgments

On behalf of the editorial office of *Annals of Joint* (*AOJ*), I would like to extend my gratitude to Prof. Chao for sharing his opinions with us.
Funding: None.

doi: 10.21037/aoj.2017.12.03
Cite this article as: Wang J. Prof. Edmund Y. S. Chao: time is limited, but enthusiasm is unlimited. Ann Joint 2017;2:81.

Footnote

Provenance and Peer Review: This article was commissioned by the Editorial Office, *Annals of Joint* for the series "Meet the Professor". The article did not undergo external peer review.

Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aoj.2017.12.03). The series "Meet the Professor" was commissioned by the editorial office without any funding or sponsorship. JW reports that she is a full-time employer of AME Publishing Company (publisher of the journal). The author has no other conflicts of interest to declare.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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(Science Editor: Julia Wang, AOJ, aoj@amegroups.com)

