MENTORS IN ORTHOPEDICS

HIROYUKI TSUCHIYA

https://doi.org/10.71165/joro-2w4f

SUMMARY

Professor Hiroyuki Tsuchiya's trajectory from rural Gunma to the chairmanship at Kanazawa University reflects a career defined by technical convergence. Driven by early personal loss, he transitioned to musculoskeletal oncology, where he integrated the Ilizarov method with limb-salvage surgery. His development of iodine-coated implants and caffeine-potentiated chemotherapy addresses the critical intersection of malignancy and infection. As incoming WAIOT president, Tsuchiya remains focused on biological reconstruction and mentoring the next generation through a philosophy of persistent, evidence-based innovation.

From rural Gunma to global eminence, Professor Hiroyuki Tsuchiya's journey in orthopedic surgery is marked by innovation and perseverance. His pioneering work in musculoskeletal oncology, the Ilizarov method, and infection control, particularly the development of iodine-coated implants, showcases his inventive approach. Tsuchiya's philosophy—"Dream, dare, and do"—and his reflections on life's essence reveal a mentor who values cheerfulness, hard work, and gratitude, inspiring the next generation of orthopedic surgeons.

Can you tell us about your background? Where were you born and raised?

> I was born in Gunma Prefecture, which is located about 100 km northwest of Tokyo. I'm not sure if you're familiar with Japanese geography, but that's where I spent my formative years until I was 19. I completed my elementary, junior high, and senior high school education there before moving on to university.

Where did you attend university?

> I attended Kanazawa University in Ishikawa Prefecture. It's about 400 km west of Tokyo, facing the Sea of Japan, with the Korean Peninsula on the opposite side. Kanazawa University is one of the oldest universities in Japan, with a history spanning over 150 years. In fact, it's probably the third oldest university in the country.

Why did you choose this particular university?

> I chose Kanazawa University for its medical school. At that time, the university was located within a castle, which made for a beautiful setting. The combination of its excellent medical program and the stunning location made it an appealing choice for me.

What motivated you to pursue medicine?

> To put it briefly, my decision to study medicine was deeply personal. When I was in high school, my father passed away from liver cirrhosis, likely due to alcoholism rather than viral causes. I felt incredibly frustrated by the lack of treatment options available for his condition. This experience ignited my desire to become a doctor and find a cure for liver cirrhosis. Interestingly, while that was my initial motivation, I ultimately became an orthopedic surgeon rather than a physician specializing in liver diseases. Time changes people.

Why did you eventually choose orthopedic surgery?

> During my medical studies, I was exposed to various fields of medicine. However, I was particularly drawn to the orthopedic department. The atmosphere there was vibrant – patients, doctors, and nurses all seemed cheerful and energetic. Additionally, considering the aging population and the increasing number of elderly people, I recognized a growing need for orthopedic surgeons. I felt that orthopedics had great potential for growth and impact, which ultimately led me to choose this specialty.

You mentioned robotic surgery earlier. What is your view on the current systems available? What benefits do they offer, and what do you think the next generation of surgical robots will bring?

> I am very excited about the robotic systems in orthopedic surgery, and I'm a strong believer in their potential. We have studied alignment and component placement extensively, and while there are already numerous studies out there, the precision achieved with robotics is extremely impressive. For the first time, surgeons are able to control every single step of the arthroplasty surgery with a very high precision.

Did you stay at the same university for your orthopedic surgery training?

> Yes, I remained at Kanazawa University. After graduating from medical school, I completed my residency at Kanazawa University Hospital. Subsequently, I entered the graduate school of medicine there to pursue my PhD. I thought that there is still room for basic research in orthopedics to be developed in Kanazawa.

What was the topic of your PhD research?

> My PhD research focused on caffeine, specifically its effects on cancer cells. I discovered that caffeine inhibits DNA repair in cancer cells after they've been damaged. This was particularly relevant to my work in orthopedic oncology, as I was involved in sarcoma chemotherapy. My research led to the development of a new chemotherapy protocol for osteosarcoma and other sarcomas, which we called caffeine-potentiated chemotherapy. This approach significantly enhanced the effectiveness of anti-cancer drugs, allowing us to minimize tumor excision and preserve more healthy soft tissue, muscles, nerves, and blood vessels, ultimately leading to better limb function for patients in addition to improving survival rates.

When did you complete your PhD?

> I graduated from medical school in 1983 and spent five years on my PhD studies at Graduate School of Medical Sciences, Kanazawa University. I received my PhD in 1988.

Were you already interested in orthopedic tumor surgery at that time?

> Yes, I was already deeply interested in musculoskeletal oncology during my PhD studies and early career because musculoskeletal oncology is the most challenging area in Orthopedic surgery. It is necessary for musculoskeletal oncology to bring together all the knowledge and skills in the field of orthopedics.

What came next in your career?

> After completing my PhD, I became fully immersed in musculoskeletal oncology, developing various surgical procedures. In the early 1990s, I encountered the Ilizarov method, which involves bone lengthening and distraction osteogenesis. This technique, using external fixation, proved valuable for fractures, limb lengthening, bone defect reconstruction, and treating osteomyelitis. I also tackled many challenging cases of infected non-union, which was a significant problem in orthopedic surgery. My work naturally led me to focus on orthopedic infections in both tumor surgery and Ilizarov procedures.

Where were you working during this time?

> I remained at Kanazawa University Hospital throughout my career, from the beginning until my retirement. I maintained a very consistent path, staying with the same institution throughout my professional life.

Did you complete any fellowships abroad or at other hospitals?

> Yes, I spent almost a year at the University of Vienna under the supervision of Professor Rainer Kotz, a renowned tumor surgeon who developed modular tumor prostheses. Vienna University was and still is famous for orthopedic surgery. This fellowship took place from 1991 to 1992. Additionally, I enjoyed several traveling fellowships to the United States, visiting five times to study tumor surgery and the Ilizarov method of external fixation.

Who were some of the important mentors in the early part of your career?

> While I've had many influential figures in my career, including professors from my orthopedic department and international mentors like Professor Rainer Kotz, I want to emphasize that my most important mentors have been my patients. They've taught me invaluable lessons throughout my career. Of course, I also greatly respect my predecessors - all the great orthopedic surgeons who have achieved so much in our field. But primarily, I consider my patients to be my greatest teachers.

Can you tell us about your work environment and how orthopedic departments are typically organized in Japan?

> I became a professor and chairman of the department in 2010. At that time, I had over 80 graduate students pursuing their PhDs under my supervision. I also taught numerous medical students. Our department consisted of about 15 staff members, including myself as professor and chairman, one professor, two associate professors, two lecturers, and several assistant professors.

> We were organized into specialized teams: tumor, spine, joint, hand, foot and ankle, sport medicine and rehabilitation. This structure allowed us to cover all fields of orthopedic surgery within the department, with a range of professionals in each area.

Are there specific fields within orthopedics that particularly interest you?

> My main interests lie in musculoskeletal oncology and the Ilizarov method, which includes treating bone infections. I was also heavily involved in basic research. However, as the department head, I oversaw and managed all fields of orthopedic surgery.

Regarding musculoskeletal tumor surgery and infection, have you seen advancements with implants, such as nanotechnology? What are your thoughts on this?

> Indeed, there have been significant advancements. In tumor surgery, the infection rate is quite high compared to other orthopedic surgeries - about 10 to 20 times higher. Recognizing this issue, I've been working on developing antimicrobial implants. Around 2006 or 2007, I developed an antibacterial coating for orthopedic implants using iodine. Iodine is a highly effective element for controlling infection. We've patented this technology, and I'm currently waiting for iodine-coated implants to enter the market. We expect a total hip system coated with iodine to become available by the end of this year or next year.

Which company is working on this patented technology?

> While I was initially unsure if I could disclose this information, it's actually public knowledge. The company working on this is an American company.

How are bone and joint infections typically managed in Japan? Is there a specific network or national society focused on this?

> Yes, we have the Japanese Society for Study of Bone and Joint Infections, which is a very well-established organization with a history of about 50 years. Additionally, I'm a member of the Japan Association for the Study of External Fixation and Limb Lengthening (ASAMI-Japan). The introduction of the Ilizarov method has significantly improved our ability to treat difficult cases of infected non-union and osteomyelitis.

What are the main bacteria causing infections in Japan?

> The bacterial profile is similar to what you'd find worldwide. Staphylococcus aureus is the most common, with MRSA cases increasing. We also encounter mixed infections, including Staphylococcus epidermidis, Pseudomonas aeruginosa and so on. Fungal infections are particularly challenging to treat.

What about antibiotic-resistant bacteria?

> We're seeing an increase in antibiotic-resistant bacteria, largely due to the widespread use of antibiotics. This is why I've been focusing on developing the iodine coating for implants. Iodine is effective against bacteria, viruses, and fungi without inducing resistance, making it an excellent material for infection control.

Can you tell us more about the development of the iodine coating?

> I began developing the iodine coating around 2006-2007. It was a collaborative effort involving the microbiology department at our university, the orthopedic surgery department, and the Chiba Institute of Technology. Professor Takaya, an engineer from Chiba Institute who unfortunately passed away over 10 years ago, played a crucial role in developing the iodine treatment technology.

> The coating can be applied to all titanium implants, which are widely used in orthopedics. This includes hip and knee implants, fracture fixation materials like intramedullary nails and locking plates, and spinal instrumentation. However, it's not possible to apply the coating to stainless steel or cobalt-chrome implants.

Are there other innovations in the field of bone and joint infection (BJI) treatment in Japan, such as phage therapy?

> Phage therapy is not currently available in Japan. As for BJI treatment, we follow standard protocols. For early-stage infections, we attempt DAIR (Debridement, Antibiotics, Implant Retention). If that's not possible, we proceed with either one-stage or two-stage revision surgery. We use antibiotic-impregnated bone cement, typically with vancomycin or sometimes a combination of two antibiotics. The choice between one-stage and two-stage revision remains debatable, but in my practice, I generally prefer the two-stage approach, especially for more complex cases.

How do you manage soft tissue issues? Do you collaborate with plastic surgeons for procedures like muscular flaps?

> In our department, we have our own microsurgical team capable of performing various procedures, including flaps, vascularized bone transfers, and myocutaneous flaps. This in-house expertise is very useful for managing complex cases.

Do you combine bone transfer techniques with the Ilizarov method?

> Yes, I'm particularly fond of the Ilizarov method, especially bone transport. It's an excellent procedure for controlling infection and addressing bone defects. As Ilizarov said, "In the fire of bone regeneration, infection will be burned out." However, it's crucial to have expertise in using this technique.

Is the Ilizarov method widely known among orthopedic surgeons in Japan?

> Yes, it's relatively well-known in Japan. The ASAMI Japan Society, which focuses on the Ilizarov method and external fixation, has over 250 members. More than 200 orthopedic surgeons in Japan can perform correct Ilizarov procedures. I initially learned about external fixation and the Ilizarov method from American and Italian doctors, including Maurizio Catagni in Lecco, Italy. In the United States, I learned a lot from Dr. Paley and Dr. Herzenberg. I spent time as a traveling fellow at their institute before bringing these techniques back to Japan.

How many patients have you treated using the Ilizarov method in Japan?

> I began using the Ilizarov method in 1992-1993, so it's been nearly 30 years now. Over this period, I've treated more than 1,000 patients using the Ilizarov procedure with external fixation, bone lengthening, and bone transport. I've even applied the Ilizarov method for reconstruction in

> tumor patients. In fact, I believe I was the first to use bone transport for reconstruction after tumor resection.

Are there any societies in Japan or international societies that you find interesting and have been happy to be involved with?

> Certainly. The largest Japanese society I'm involved with is the Japanese Orthopaedic Association (JOA). It currently has about 26,000 members. I served as a board member for several years, and three years ago, I had the honor of being the congress president for the annual JOA meeting in Tokyo.

> I'm also involved in other orthopedic societies, including those focused on pediatric orthopedics and tumor research. Internationally, I'm currently a board member of the World Association against Infection in Orthopaedics, Trauma (WAIOT) and the International Society of Limb Salvage (ISOLS) and Asian Pacific Musculoskeletal Tumor Society (APMSTS). I was previously a committee member of the SICOT Infection committee, but I've since stepped down from that role.

Can you tell us a little bit about the International Society of Limb Salvage?

> The International Society of Limb Salvage (ISOLS) was established in 1981 by a group of tumor surgeons. Since then, limb salvage surgery in musculoskeletal oncology has become widely adopted and refined. Today, we can perform limb-sparing surgery very safely based on a strategy that combines adequate chemotherapy, precise tumor excision, and appropriate reconstruction. In advanced countries, the limb salvage rate for osteosarcoma is now probably over 90%.

> About 85-90% of ISOLS members are orthopedic surgeons, with the remainder being chemotherapists, radiologists, pathologists, and occasionally radiotherapists. This multidisciplinary approach is crucial in the field of musculoskeletal oncology.

> In 2017, I had the privilege of hosting the ISOLS meeting in my city, Kanazawa, as the congress president. Following that, I served as the society's president from 2017 to 2019.

> During my career, I've developed several innovative procedures. One that I'm particularly proud of is the frozen autograft technique. This involves freezing the resected tumor bone in liquid nitrogen for 20 minutes, which effectively kills all cells while preserving the bone structure. The treated bone can then be reimplanted, and over time, it becomes revitalized as osteogenic cells and blood vessels grow into it. This procedure has now been adopted worldwide, including in several European countries.I've also developed other techniques, such as iodine coating for antibacterial implants and a caffeine-potentiated chemotherapy method. Unfortunately, we didn't secure a patent for the latter, so it hasn't been commercialized.

Can you tell us about your work on osteomyelitis and chronic infected non-union?

> I've developed an interesting procedure for treating osteomyelitis and chronic infected non-union. After thoroughly debriding the infected area, we irrigate it with an iodine solution. Then, we reconstruct the bony defect or cavity using a paste-like bone substitute, typically α-Tricalcium phosphate (αTCP), mixed with antibiotics.

> This method is superior to using antibiotic-loaded bone cement because it allows for a much higher release of antibiotics over time. With bone cement, less than 10% of the antibiotics are

> typically released, whereas with this bone substitute method, more than 80% of the antibiotics are released over a period of 3-4 weeks. This makes it very effective in controlling infection.

> We can use various antibiotics with this method, including vancomycin. It's particularly effective for infected non-union cases where we can preserve one cortical wall and apply the antibiotic-loaded bone substitute. Over time, this leads to union and control of the infection.

You are doing basic research too, any work you'd like to mention?

> Yes, I'd like to mention my work in regenerative medicine using stem cells. I'm particularly interested in using fat-derived stem cells for bone regeneration and union. These cells are also very effective against infection because they produce antibacterial peptides. We've found that combining fat-derived stem cells with antibiotics creates a synergistic effect, especially useful in treating septic arthritis. We've already published on this topic.

Can you give us some historical perspective on WAIOT and why you've been interested in being involved?

> My involvement with WAIOT (World Association against Infection in Orthopedics and Trauma) began about seven or eight years ago when I met Carlo Romano at a Greek Orthopaedic Association meeting organized by Professor Konstantinos Malizos. I presented on iodine coating, and Carlo discussed his work on antibiotic gel. We became good friends, and Carlo introduced me to WAIOT, encouraging me to join. Since then, I've been actively involved with WAIOT. I organized the annual meeting of the Japan Bone and Joint Infection Society in Kanazawa, where I invited both Carlo and Dr. Javad Parvizi, an authority on periprosthetic joint infection (PJI).

> This year, the WAIOT meeting is being organized by Dr. Joseph Benevenia in the United States. Following that, I'll have the honour of being the president of WAIOT and organizing the WAIOT meeting in Yokohama, Japan, in September 2025 together with the Congress President Professor Yutaka Inaba, Professor and Chairman, Department of Orthopaedics, Yokohama City University.

What would you like to focus on during the WAIOT conference in Japan?

> For the upcoming WAIOT meeting in Japan, we plan to cover a wide range of orthopedic fields, including spine, hand, foot, and trauma. Given my co-worker's expertise, one symposium will certainly focus on periprosthetic joint infection (PJI), covering its prevention, diagnosis, and treatment.Personally, I'm very interested in antibacterial materials and coatings, including the use of iodine, antibiotics, and potentially silver. We'll also discuss innovative approaches like Carlo's antibiotic gel.

> Our goal is to make the WAIOT meeting in Japan very fruitful, combining cutting-edge scientific discussions with engaging social events.

As a final question, what advice would you give to young surgeons who look up to your career and achievements?

> My advice to young doctors can be summed up in a few key points. First, my motto: "Dream, dare, and do." It's about challenging yourself and realizing your dreams.

> Second, I always tell young doctors in our department to "be cheerful, be joyful, and be energetic." This positive attitude is crucial for success in your dreams.

> Lastly, I'd like to share a quote from the father of rocketry, which has always inspired me: "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." This encapsulates my belief in the power of perseverance and innovation.