

MICHEL BONNIN

<https://doi.org/10.71165/mos4-jtba>

SUMMARY

A native of Burgundy who found his clinical calling within the Lyonnaise school, Michel Bonnin has dedicated his career to the precise restoration of native knee anatomy. From early biomechanical research on tibial slope under Henry Dejour to the development of customized prosthetic designs and robotic integration, his work emphasizes 3D planning and individualized care. As President of the European Knee Society, he now focuses on standardizing these technological advancements while maintaining a commitment to surgical education.



A son of Burgundy, Michel Bonnin found his path in Lyonnaise orthopedics. This school of thought shaped his journey, from internship to cutting-edge prosthetic surgery. Through encounters and innovations, he built an international career, driven by a leitmotif: reproducing anatomy as accurately as possible for the well-being of the patient.

Michel, where are you from? Are you a native or adopted Lyonnais?

I am not at all a native of Lyon, I am a pure Burgundian. My whole family is originally from Burgundy, for generations. I did my medical studies and all my schooling in Dijon, and I arrived in Lyon late, in 1984, after passing the internship exam. Quite an adventure for the provincial boy I was!

What attracted you to Lyon?

At the time, Dijon was very influenced by the Lyon school. It should be noted that the Dijon medical school was created in the 1960s essentially with professors who came from Lyon. During my studies, I diligently read the famous Cahiers médicaux lyonnais, a fabulous journal to which I subscribed. It was the best medical journal of the time! When I passed the internship exam, I hesitated between Paris where I was ranked 2nd and Lyon where I was 3rd. But my early interest in orthopedics and knee pathology naturally drew me to Lyon. And all my internship questions in these fields were written by the Lyonnais Georges Gonon and Jean Paul Carret! It was a sign.

Speaking of which, what led you to orthopedics so early on?

It's multifactorial, a matter of encounters. My first surgical internship in cardiology bored me a bit, I felt we were just the hand of the cardiologist, there was no exciting diagnostic process. On the other hand, the second one with Professor Henry Dejour was a revelation. The atmosphere in his department was extraordinary, worthy of a start-up before its time! Ideas were flying everywhere, people were ultra-motivated, working from morning to night in an exciting atmosphere. All this orchestrated by Dejour's extraordinary personality, reputed to be tyrannical but in fact deeply human and inspiring. He pushed everyone to give their best. And what personalities in this department! Jean-Paul Carret who was introducing biomechanics, Pierre Chambat whom everyone dreamed of imitating, Gilles Walch who was developing shoulder prostheses... Once I tasted this intellectual effervescence, I remained anchored in this department. We woke up thinking 'knee', we operated knees all day, we fell asleep thinking 'knee'!

Did you focus on all three joints during your Lyon internship?

Mainly the knee and hip actually. The ankle was embryonic at the time. I did two internship semesters with Dejour but I stayed working in the department throughout my internship, for the famous knee days, conferences, research. It was thanks to Jean-Paul Carret that I was able to do a DEA in biomechanics and biomaterials, we worked with the École centrale de Lyon to manufacture prototypes, with INSA on robots, it was fascinating. For the hip, I learned a lot from Jean-Paul Carret as well, and from Jean-Claude Cartillier, a pioneer of hydroxyapatite prostheses at the Clinique Mutualiste where I was his first intern. I remember participating in the placement of the first Corail prosthesis in Lyon, quite an event! Cartillier had an aura of a company leader, very charismatic, didactic, demanding. A great school.

After your internship, you were chief resident with Professor Dejour?

Yes, for two formidable years, and I then went into private practice at the Clinique Charcot, while remaining attached to Henry Dejour's department until his retirement. I helped him with consultations and heavy prosthetic revisions when Jean-Paul Carret broke his leg. I juggled between my two activities, a real challenge!

Your medical thesis focused on the influence of tibial slope in biomechanics. Were you already interested in that?

When I asked Dejour for a thesis topic, he said "Michel, you're going to work on single-leg stance". It was a new theme in the department and I was a bit lost! Gilles Walch guided me by suggesting to analyze the weight-bearing radiographs of all the patients in the department operated on for anterior cruciate ligament tear. By cross-checking the files, I realized that the greater the slope, the more the femur slid backwards. A discovery! Encouraged by Chambat, we managed to statistically show the link between the slope, tibial translation, and the risk of ACL rupture and evolution toward osteoarthritis. A major advance for the time, it paved the way for deflexion osteotomies. In parallel, with Jean Paul Carret, we set up a single-leg stance simulator in the anatomy lab, and studied knee kinematics with robots from INSA. I presented my thesis at the ESSKA congress in Stockholm in 1990: it was my first congress!

Anatomy has been the common thread throughout your career.

Absolutely. I must say that I was immersed in basic sciences since childhood. My mother was a math teacher, my father a math researcher, so I was spoon-fed rigorous reasoning! But it was anatomy that fascinated me from my first years of medical school. This ability to visualize structures in 3D, to understand the architecture of the body... I even won two anatomy prizes at the Dijon medical school. This passion for anatomy has truly guided my entire career, with biomechanics as the pinnacle. I have therefore always wanted to reproduce the native anatomy as finely as possible with surgery.

You also did a PhD on this subject?

Yes, a PhD at the University of Ghent in Belgium, to study how to reproduce the native anatomy with knee prostheses, by analyzing the subtle interactions between bones and soft tissues. In prosthetic surgery, we often have a 'biased' vision by focusing on what is visible on X-rays: the bones and bone-to-bone joints. But the soft tissues play a crucial role and form a true joint with the bone surfaces, ignored because invisible! Tissue friction and residual laxity are moreover sources of pain often neglected after knee prostheses.

You were among the first to show the impact of prosthetic oversizing on this pain...

As early as the 2000s, I systematically performed preoperative CT scans on my patients and spent hours analyzing them. It made me aware of the immense anatomical variability of knees, and the difficulty of reproducing it with the 'standard' prostheses available at the time, which offered at best 6 or 7 sizes. By comparing the CT scans and the implanted prostheses, we were able to show a clear correlation: the more the prosthesis overflowed the native bone envelope, the worse the pain scores and the more limited the range of flexion. Conversely, slight undersizing gave much better results. A real surprise!

Speaking of which, during your career you worked with different manufacturers on quite different prostheses.

I indeed grew up with the HLS mobile-bearing prosthesis and the very "Lyonnais" third condyle and I obtained very good results with these implants. But despite its qualities, the number of available sizes remained limited for a long time, forcing compromises. In the early 2000s, with the emergence of 3D printers and technological advances, I thought we should aim to create fully customized prostheses for each patient, a bit like dental prostheses. It seemed crazy at the time! With Alain Tornier, a visionary leader, we worked a lot on such a project, especially in the anatomy lab. But the partial buyout of Tornier by American pension funds unfortunately stopped the funding and these studies had to be abandoned for economic reasons. A big disappointment.

How did the development of the custom prosthesis at Symbios go?

A great encounter! During the Lyon Knee Days in 2010, I presented, with my lifelong friend Tarik Ait Si Selmi, a communication on the feasibility of custom prostheses. Jean Plé, the head of Symbios, heard us and was immediately enthusiastic about this project. It should be noted that the DNA of Symbios was precisely the personalization of prostheses; Symbios engineers were precursors with custom hip prostheses since the late 1980s. Very quickly, we got to work. The agility of a company of this size allowed us to progress quite quickly, even if major industrial challenges had to be solved, such as the choice of materials and manufacturing processes. Not

easy to manufacture a prosthesis from scratch! We tested the individualization of molds by stereolithography but the resulting metal was too fragile. Then 3D printing in cobalt-chrome, but it was too expensive. We ended up developing a conventional molding process with rudimentary "pre-prostheses", subsequently customized by rapid robotic machining, once the patient's CT scan was received. All of this took years to perfect.

Strategic issues also had to be decided, such as alignment management, the acceptable degree of restitution of the native deformity... We were then in the midst of controversy, the dogma of mechanical alignment was barely crumbling. We erred on the side of caution by opting for a "restricted" anatomical alignment, preserving the starting morphotype... within a certain limit. Similarly for ligament preservation, if our initial ambition was the preservation of both cruciate ligaments, we initially opted for a more classic posterior-stabilized design to secure the process, before secondarily moving to posterior cruciate retention, which goes well with the anatomic-functional alignment. This back and forth between the desirable and the feasible fueled many discussions, many models and many trials, I can tell you! Finally, the CE mark was obtained in 2018. A real source of pride.

How do you manage the tibial slope and ligaments with a custom prosthesis?

The sagittal plane is crucial! We must also reproduce the sagittal anatomy, but in a controlled - or restricted - way because an excessive slope without anterior cruciate ligament is a recipe for disaster. Initially, we aimed to preserve all ligaments, including the 2 cruciates, but it was very ambitious. We started cautiously with a more reassuring posterior-stabilized design, before evolving towards posterior cruciate retention, which indeed goes very well with the reproduction of the native alignment. When the orientation of the joint line is preserved, retaining this powerful ligament that is the PCL becomes much simpler and more logical. It works hand in hand with a respected slope.

This is where the patellofemoral and femorotibial decoupling makes perfect sense.

Exactly. From an evolutionary point of view, these two joints were totally separate before bipedalism. The rather recent fusion of the trochlea and condyles (from a phylogenetic point of view) explains the incredible anatomical variability of the trochlea, especially in its orientation. Impossible to restore it perfectly with a standard monoblock prosthesis, especially if the alignment is also individualized! The custom design allows to preserve the orientation of the joint line, guarantor of the femorotibial biomechanics, while reproducing identically the orientation of the native trochlea. That's the key. We recently showed it in a randomized prospective study with more than 300 patients: patellar centering seems to be more reproducible.

How do you see robotics integrating with this search for anatomical restoration?

I think robotics and individualized implants are complementary and will eventually converge. Custom takes care of design issues, robotics brings precision to the procedure and will simplify the surgery in the end. We currently spend a lot of time placing guides, removing them, adjusting them... So many time-consuming steps and sources of approximation. The idea is to have a user-friendly tool that links preoperative planning to the surgical procedure to automate and secure the cuts. That's why we created the start-up Ganymed Robotics with hyper-creative young engineers, to develop a system without trackers or infrared sighting, simpler and faster to use. I am convinced that the future lies there.

3D imaging is crucial in your opinion?

Absolutely. All my prostheses, whether hip or knee, have been planned on CT scans for ages. In prosthetic surgery, 1 mm more or less in a cut, 1° of orientation one way or the other, it changes everything. The 2D radiological assessment is too imprecise. The 3D gives the true dimensions and allows to program exactly in the ideal cutting plane. CT planning is fundamental to restore anatomy and simplify surgery. We are currently experiencing a real paradigm shift. Until now, orthopedic surgery remained very artisanal and dependent on the operator's experience. Tomorrow, with new technologies, we will be able to standardize procedures and smooth out the results. It's exciting and promising for the future.

You have a taste for transmission. You participated in the writing of reference books on knee osteoarthritis. How did this come about?

I had made contacts with Springer editions since my chief residency. On the occasion of a meeting with them, I submitted the idea of a reference book on knee osteoarthritis and they were thrilled. I immediately got my friend and mentor Pierre Chambat on board, and we set out to bring together the best international experts to write this book. It was quite a challenge! In the French version, I had to translate all the chapters written by English-speaking authors, and vice versa for the English edition. I spent sleepless nights on these translations, but it was worth it. We really wanted an exhaustive and didactic work, covering all aspects of this complex and widespread pathology. The book came out in 2004 under the title "Knee osteoarthritis", then with a complete update in English in 2008. We did it again with "The Knee Joint: surgical techniques and strategy" in 2012, a 103-chapter book edited with Jacques Menetrey and Johan Bellemans. Two 500-page tomes, a hell of an editorial adventure but a great success that remains a reference.

Which learned societies have counted the most for you?

My first family is clearly the SFHG (French Society of Hip and Knee) of which I was assistant secretary, then general secretary, and president for many years. Thanks to the efforts of Jacques Tabutin and successive presidents and boards, this small confidential society has transformed into an open and radiant structure. Today, it is a dynamic society that brings together nearly 500 French surgeons, with a flagship scientific meeting during SOFCOT that always fills the room, and very popular spring days. This year, we are innovating with a joint SFHG-EKS day that testifies to our growing aura. The SFHG contributes to structuring and promoting the major historical contribution of French orthopedics, particularly in prosthetic surgery! Beyond borders, I have also always been involved in ESSKA, especially via the famous Traveling Fellowship to the United States in 1999, a fabulous obstacle course alongside Giancarlo Puddu, Jacques Menetrey and Johan Bellemans. We remained very close, which led to the creation of the EKS, the European Knee Society, officially founded in 2015 and of which I have the honor of being the president today. EKS quickly became the cenacle of European arthroplasty, with currently 95 active members, and associates, and 20 junior members representing the future of our specialty.

Tell us about the WAC (World Arthroplasty Congress) of which EKS is a part.

The idea of WAC germinated in 2014 under the impetus of Jean-Noël Argenson, then president of EKS, and Norman Scott, then president of ICJR (International Congress for Joint Reconstruction), with the ambition to create THE world reference congress on hip and knee prostheses, bringing together the best experts. After a founding edition in Paris in 2015, a confirmation in Rome in

2018, we are finalizing the 4th edition in Madrid in April 2024. A must-attend event that brings together more than 1,200 delegates with a strong American, European and Asian representation, its trademark. EKS is obviously part of it, alongside EHS (European Hip Society) on the European side, and AKS (American Knee Society), AHS (American Hip Society) and IOEN (International Orthopedic Education Network, which replaces ICJR) on the American side. Two intense days of conferences, a joint hip-knee session, a memorable gala dinner... A unique atmosphere.

What will be the major themes addressed in Madrid?

We will cover all the significant advances: new technologies, anatomical restoration, biomechanics, complication prevention, fast recovery... With very didactic sessions for the young generation, and hyperspecialized round tables on the most innovative concepts. Not forgetting e-health, data management, environmental issues... Because prosthetic surgery is at a real turning point. The idea is really to compare visions, decompartmentalize practices, with a lot of time dedicated to informal discussions and exchanges, the DNA of WAC. The partner industry will also present its latest innovations, with a certain number of exclusives.

Finally, what are your passions outside of surgery?

Ah, I am categorical: I NEVER finish a day without going swimming! It's my daily decompression chamber. I come out of the OR, often late, tired, and hop, straight to the pool. It magically empties my head and I arrive home light, available, with a free mind. Swimming has always been my balance. Music too, especially the piano. I'm not a great virtuoso but it relaxes me, it's my form of meditation, of letting go. And of course I love sports in general, competition. Running, cycling, a bit of golf... And skiing obviously, my hobby! I am a convinced mountain dweller, Lyon is great for that. As soon as I can, I rush to the slopes, whatever the weather. My children passed on the virus to me, we often go riding together. And recently I got into the Olympic 49er dinghy, derived from the Australian 18-footers... an incredible sensation of gliding and freedom. Obviously, given my old age, I stick to calm conditions... My dream would be to be able to sail much more often. But all in good time!