

Review Article

Days of Greatness: An Unlikely Journey of Discovery with Dr. Larry Dorr

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From January 2017 through December 2020, this author experienced the very unusual opportunity to join and collaborate with one of the greats in Orthopedic Surgery, Dr. Lawrence (Larry) Dorr, in a quest to unravel the spinopelvic postural effects on acetabular component positioning in total hip replacements. With approximately 1500 email communications, a true collaboration culminating in multiple papers including the work that brought the demise of the Lewinnek zone as a measure of safety. The journey from community private practice to elite status in arthroplasty clinical research on this topic is relived to share with readers the tremendous satisfaction possible when one follows their calling with "maximum effort".



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I turned 65 this year and have practiced orthopedic surgery since 1989. It has been the only profession I ever wanted with only a dabble into cardiovascular surgery on the famous Shumway Service (with Bill Maloney, the present chair) at Stanford University in 1983. My training in orthopedics was at the University of Pennsylvania, a decidedly research oriented program, and the experience convinced me the political environment of the university was not my ideal setting. I completed a mini-AO trauma fellowship in Innsbruck and an arthroscopic knee surgery fellowship with Dr. Richard Steadman before settling into private practice with a solo practitioner in Sonoma County, California that summer. It was community private practice, taking on whatever I felt capable of doing, and I buried myself into becoming as good a surgeon as possible. Research was no longer a thought, textbooks and technique manuals were my passion. I collected both and the library of our small practice, with its wall of bound editions of the

great journals of the day, became my secure home. After several years, the fantastic transformation from a young, greener surgeon to an experienced technician was accomplished and I only researched how to deal with a particular case's problem. I developed skills at long bone trauma, both upper and lower limb including foot/ankle and hand cases, primary total joints, simpler revisions, arthroscopic knee and the developing field of shoulder arthroscopy and sports medicine cases that make up the bread and butter of community practice.

With the advent of the internet and digital education, orthopedic surgery exploded with information. So much so that, within a few years, it felt impossible to keep up with the constant evolution. Learning surgery from textbook or journal descriptions as I had was difficult but watching experts operate on video was game changing, surgical complexities only grew as more and more people subspecialized and these videos drove the fields forward. Hip arthroscopy

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appeared and I watched it develop into an extensive specialty of its own. Private practice became a game of just trying to keep up and perfecting those elective operations you truly enjoyed and did frequently.

I attended the AAOS Academy meetings yearly but my focus had clearly changed. No longer was it enjoyable sitting in dark halls to hear scores of 6-minute presentations often having little relevance to my practice. I found myself drawn to the Exhibitor Floor, for it seemed here was where real innovation was born. I hadn't understood that academics was the entryway to working with companies on designing new devices, instruments, and systems but I had learned if I wanted to discover the future, if I wanted to find something that spurred my passion, it was going to be here. Innovation was everywhere and for years I spent 3 exhilarating days searching. In 2015, it happened, I found my calling.

Las Vegas, Nevada, under the Palazzo and Venetian Hotels, at a smaller Corin company booth that I knew nothing about. They were studying films of the pelvis for hip replacement surgery, but from the side, lateral views in unusual positions. I found someone to assist me, his name was Brad Miles, an engineer who spent the next 2 hours educating me. His group matched hip component placement to the motions of the patient's pelvis, captured with these lateral standing and seated lateral films. My reply, "Wait, wait, again, you said the pelvis moves? How does it move, no one ever taught me it moves?" The entire room had disappeared, people he introduced me to were invisible, that man had just rocked my world. I enjoyed doing hip replacements and cup positioning was a huge source of frustration to me. I always tried to ensure the cup would go where I wanted it to, however, post op x-rays often showed I was off, despite using the mechanical positioner and full exposure with classic posterior approach. This discussion certainly captured my interest, but the following day sealed the deal. That morning, I wandered through the poster hall and in atypical fashion, found myself in the spine section. There I saw something that just stopped me in my tracks. It was a poster from the UC Irvine group with 4 lateral views of the pelvis including implanted THA cups defining a classification system that confirmed just what Brad Miles had taught me. Functional patterns of pelvic tilt and mobility that determined the orientation and fate of the acetabular component. I spent at least an hour staring at this poster and I was forever converted. This poster later be-

came the oft cited 2015 Phan et al paper in BJJ, *The Influence of sagittal spinal deformity on anteversion of the acetabular component in total hip arthroplasty*, the first integrated classification system of spinopelvic derangements regarding cup anteversion planning. Mr. Miles' Australian outfit, OPS, worked through a complex proprietary algorithm and there was little published in the US. So, I made a decision. On my 58th birthday, I became a researcher.

I read everything I could, the internet made it a cakewalk compared to my old trips to the library with hours spent pressing bound journals onto the glass top of a copying machine. I had no university free access to material but it became quickly apparent the leading light in the field was a Parisian hip-spine surgeon who studied patients on the most incredible biomechanical imaging machine I had ever seen, his name was Jean-Yves Lazennec and his machine was the EOS Imaging System (Atec, Carlsbad, Ca). To this day, his papers from 2004-13 were the most fascinating series of works I've ever tackled, filled with new observations and insights, creating a whole new world of acetabular mechanics and pathomechanics never before imagined. Geometric relationships, simple algebraic equations tying the cup to the pelvic position in space, in functional standing and sitting positions (I would recommend Lazennec JY, Brusson A, Rousseau MA. *Hip-Spine Relations: An Innovative Paradigm in THR Surgery*. 2013 Intechopen.com as an outstanding review of this work). It was biomechanically straightforward and pointed to a new future for hip replacement. A better way to plan, and to my mind a doorway to 3-dimensional planning sequences. No way was I stopping here, this became a quest into the science of posture itself, a foray into an amazing triumph of spinal mechanics nearly all emanating from French researchers. I learned about the pelvis and its descriptive parameters from Duval-Beapere and Legaye, and the incredible compensatory mechanisms that had turned adult spinal deformity surgery into an age-related algorithmic exercise in human engineering from Barrey, Roussouly, LeHuec, Farcy, and Lefage. The hip was not just about walking, sitting, and bending, it was a control point for postural alignment, Dubousset's conical kinetic chain running from the head to the foot. Now all I needed was to find the article on how to incorporate all these discoveries into clinical hip planning. One problem, it didn't exist. There was no article, no guidelines, no extension into the hip that looked beyond supine anterior pelvic

plane tilt (APP) and incorporated these magnificent postural concepts.

There was, however, one paper that looked like someone wanted to discover the same thing I was after. It was Kanawade et al., entitled, *Predictability of Acetabular Component Angular Change with Postural Shift from Standing to Sitting Position*, JBJS, 2014 and the research was led by Lawrence D. Dorr, a famous LA hip surgeon I knew by name only. It was an intense but somewhat confusing article with new terminology attempting to relate sagittal values to the coronal inclination and anteversion numbers surgeons understood. One thing was clear, he had read Lazennec's work and he knew what to do to get to the bottom of this. There were a few focused papers coming out of HSS at that time but Dorr was onto the planning track and he was my guy. I had written down a lot of my ideas and calculations in a spiral college notebook but what was I to do, just wait for the papers to come when I had incorporated all this spine knowledge that could help the effort?

I cold called Larry Dorr.

USC Orthopedic Department, waited to get through to his assistant Felicia, and left a message that I had studied up on this subject and wanted to know what he was working on, here's my email.

He answered it.

For real.

He was working on a Current Concepts for JBJS on Spine-Pelvis-Hip Relationships in the Functioning of THA, it was submitted but kept being sent back for revisions. I asked if I could see it, I might be able to help and there's a lot I know that's not in the literature. He said he'd send it to me and mentioned things he had coming out in the British Journal. I found that article, Steff et al 2017, still an underappreciated clinical gem on the subject. Since 2014, he had created an entire classification system based on his clinical data, that brought together the Phan and Kanawade works into a planning algorithm in which he delivered recommended coronal cup and combined anteversion positions for combinations of preoperative pelvic spatial tilt and mobility measures. He took the Lewinnek zone apart, added the femur into the plan, and put the cup into specific quadrants based on the patient's mechanics using his 15 years of computer navigation experience to position the implants with clinically validated findings. He implanted cups according to his strict guidelines, then measured cup and pelvic parameters in the sagittal plane to test for correlations that might show improved safety enhancement. It was brilliant clinical research despite some difficulty inherent to his nomenclature. I asked and he agreed to a meeting with him at the AAOS meeting, March 2017, in San Diego. I would get my audience. In the meanwhile, he sent me his manuscript along with some of his outlier data, preop and postop values including a parameter I was very interested in, a hip parameter that the spine surgeons had mostly ignored. As was typical, Dr Dorr had renamed it, the Pelvic Femoral Angle, PFA. His data was complex but not for me, for I now lived in the sagittal plane. I consumed it and crunched all the numbers, cup and pelvic positions added together, outliers either too high and too low in both the standing and sitting

positions. He was testing me on things no one knew about and I took it further than he could imagine. I was earning his trust and I was on fire with the exhilaration of the chase research provides to the committed mind.

We met as planned, in the lobby of the Omni Hotel across from the San Diego Convention Center and true to form, it was an audience. He sat in a low white leather chair, near the front entrance, there was no other chair near so I knelt on the carpet next to him to show him my ideas. During the half hour or so we spoke at least a dozen people walked in that front door and went straight to him like a magnet, it was then I first realized how special and revered he was. He listened to my presentation for sagittal planning, acknowledged what I was trying to do, and told me he was bound by his study guidelines to continue as he was doing but he would include me in his research and we should continue to communicate through email. Then off he went, to console an old friend in LA, hospitalized with cancer.

The Current Concepts Review was accepted and when published he included me in the acknowledgements line at the end for "contributions to the concepts" as he could not add an additional author. Seeing my name in JBJS, even in tiny acknowledgement print, brought tears to my eyes. At 60 years of age, I had contributed to Dr. Dorr's work, an academic Icon who asked no quarter and gave none in return, in an area very few knew much about at all.

I now believe that in no small way, my age was actually an asset, for with Larry Dorr every point might be contested. I had no extra deference to him that naturally occurs with residents, fellows, or young staff. It was game on and I believe he respected that I would battle it out with him, moreover, because it was all done by email, he could not use his tremendous presence and voice to influence my arguments. In fact, our first email exchange was a debate over my belief that the major descriptor of the pelvis, called the Pelvic Incidence angle, PI, played a role in cup function that could influence component risk and proper positioning. I knew it as the master postural parameter determining the very working environment in which a person and their surgically integrated cup functions. He rebuffed me, the data did not show an association between PI and cup positions. I again implored him, do not write PI off, for the hand of PI is everywhere in the postural system, it is evolution's parameter, the pervasive mark of a higher power. I did not know he was the son of a preacher, I sent him a balloon picture of the mathematical symbol of Pi π , arguing that Pi's effects were everywhere in nature but again you can't see it. I think he never forgot that discussion because 2 years later he surprised me with a manuscript that determined PI was the third highest predictor for those initial outliers he had asked me to evaluate as measured by the combined parameter of the cup and PFA that had gone on to be called Combined Sagittal Index, CSI. This parameter was found to be predictive for cup stability in late (>5 years after index surgery) dislocations, a paper published in October 2018 (JBJS, Heckmann et al). Though I was not included as an author, this paper included an illustration of the pelvis functioning as a central postural gear between the spine and lower extremities, the Pelvic Gear concept



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that I had shared with him on my only visit to his USC office. It was a remarkable feeling to see my concept in print, I understood that without his ability to produce publishable articles nothing would ever come of my work (he did remind me as Dr Ranawat had done him many years before that “all good ideas become my ideas”) so I poured everything I had into those emails and he decided what to do with it. The twinge of being left off of any given paper was the cover charge for my collaboration with the icon and when I look at this illustration in JBJS used to convey such a fundamental biomechanical concept I still swell with pride. This is the research game played at the highest level.

The Pelvic Incidence manuscript was accepted to JBJS entitled, *The Effects of Pelvic Incidence in the Functional Anatomy of the Hip Joint*, in which he validated the issue we had debated years before, proven through the very same outlier data he had tested me on. Low PI hips, accounting only for 9% of cases, had a 67% chance of spinopelvic imbalance and was most third most predictive of impingement risk and CSI outlier (particularly low sitting, the most common posterior instability risk) status. Associated with standing postural imbalance, pelvic stiffness and obligate femoral hypermobility, decompensated low PI patients may have no safe zone in which to place their cup. It is a triumph of tying the parameters of the postural system described by the spinal pioneers, with our work on pelvic mobility and functional pelvic tilt. This paper has yet to be appreciated for the contribution to hip biomechanics and surgical planning that one day it shall have, I think it is the best expression of our work together.

The most cited paper on spinopelvic mechanics, already reaching classic status is the work that took down the Lewinnek Safe Zone, the lead article in the January 2019 Journal of Arthroplasty, Tezuka et al., *Functional Safe Zone is Superior to the Lewinnek Zone for Total Hip Arthroplasty: Why the Lewinnek Safe Zone is Not Always Predictive of Stability*. This was submitted and rejected for the Hip Society Awards in an earlier version, he revised it, and sent me a draft on December 14, 2017. I never was part of his USC team’s research meetings and agendas; I simply wrote him emails constantly and he addressed whatever I brought up, would ask me my opinion, or evaluate something for him. And then manuscripts would just appear for me to critique. This manuscript was breath taking, it included his data on cup position in a functional safe zone analysis and presented the preoperative predictive factors for functional cup (CSI) outliers, asking if our long revered Lewinnek zone cup position really was the answer. I have kept a paper copy of my email review I typed late into that night, as it represents a true watershed moment between us, confirm-

ing the solution of a mystery hundreds had worked on for nearly half a century, what determines the stability of a hip construct. I wrote “...you have defined the role of the lower hinge (*the hip joint as measured by PFA*) in the regulation of hip replacement function, something never before done and the news is sobering, simply put, “The enemy is within us, the pelvis and its captive cup’s foe is the femur, and our job is to understand its patterns to keep the cup and pelvic bone safely away to minimize their bumping into each other”. The Holy Grail was never primarily the cup position, it was the interrelated mobilities of the femur and pelvis, my PI was third. Femoral mobility determined by pelvic mobility and modified by femoral version’s effect on combined anteversion. Everything is about BOTH sides of the construct and their changes over time. I felt as if I was Watson writing Crick that we had just discovered the secret of DNA, a realization of this importance comes once in a lifetime to only a few fortunate researchers and that night was ours. This paper followed a Page one editorial in the Journal of Arthroplasty penned by Drs Dorr and his closest protégé, John Callaghan, the editor in chief, *The Death of the Lewinnek Zone*. When Dr Dorr told me they were planning an editorial I told him to “let them have it, in no uncertain terms” that the Lewinnek zone was obsolete and should be abandoned. He sent the draft to me and I thought he actually was rather moderate or perhaps John had the softer touch. To be part of this historic paper with one of the fathers of hip replacement surgery, still to this day feels, pinch me unreal, a gift from above. Unimaginable for a guy working at his kitchen table in the middle of a Midwest cornfield.

He left me one more gift before his untimely passing on December 28, 2020. A paper featuring my work, sagittal plane functional geometry creating a triangular construct surrounded by all the cup and pelvic parameters, unifying them into one integrated unit. It had been the goal of my years of study to solve the optimal cup positioning riddle Lazennec’s work had created, a simple algebraic equation, $\text{Sacroacetabular Angle (SAA)} = \text{Sacral Slope (SS)} + \text{Cup Anteinclination angle (AI)}$ in both standing and sitting positions, with SAA an unknown constant created surgically with cup impaction, SS a measurable value that differs between positions and AI the ideal unknown cup angle that also changes lockstep with the moving pelvis. The geometrically derived cup position, patient specific for any combination of pelvic tilt and mobility, would be over 1000x more accurate than the 20x20 degree Lewinnek zone. Validating this solution clinically was not part of Dr Dorr’s agenda, instead he used the triangle to explain the functional anatomy of the hip joint in the native state where

all three of its corner angles were fixed anatomical values. An application I didn't even conceive of as there were no variables here, the acetabulum and the pelvis are one bone, they move as one and the pelvic mobility changes inversely with the femur's mobility. It was a simple basic science paper, published in *Journal of Arthroplasty*, online in July 2020, and in print within days of his passing in the January 2021 issue. He had given me an opening, a precedent upon which I could expand the applications of my geometric model to explain the clinical solutions for hip replacement. He knew that with my model I could predict the correct sagittal cup angles as it had predicted all his actual angles in his clinical spinopelvic groups with small exceptions. But that was too much to push for in one paper, in June of 2020 he officially retired to concentrate on writing three books he hoped to complete. I kept in contact but not the barrage of per week back and forth emails, I knew he felt content he had crossed his finish line with our papers and I would have to figure a way to proceed more independently.

We shared one connection in his personal life, a mutual connection, our love for college football. I was a Division I University team doctor, a school just 2.5 hours away from his beloved Iowa Hawkeyes, he was incredibly knowledgeable and excited about each week's game lineup. Some of my fondest memories were Friday afternoon bus rides with my team to our away games where we texted each other for hours mixing both sports and ideas on our research. I would get to my hotel room and actually draw figures of pelvic relationships on napkins, take a picture, and send it to him. He hated it, lambasting me for my computer ignorance but I didn't care for I knew it was my ideas that counted, not my academic polish. He was a genius, particularly as math was not his forte, he synthesized concepts in his mind through his remarkable study design and data, my mechanical and numeric talents just complemented him perfectly. I had become a research fellow unlike any, one with 30 years of clinical experience, and the same unquenchable drive to uncover this truth. I was his wingman for the last 3 years of his storied career and I know I helped him accomplish what he had been striving to define and solve for over 3 decades in his work.

Larry Dorr's bibliography reads like a textbook, addressing every clinical principle necessary for success in primary total hip arthroplasty, no facet did he leave untouched. Reading his papers changed my hip practice, after several months, I began sending him my cases as I incorporated my own algorithm and surgical technique for functional cup positioning. He taught me as he would a fellow, critiquing my films and sharing his clinical wisdom. I enjoyed a 3-year clinical internet fellowship with this master surgeon. He honored me with an invitation to join his Operation Walk team's 2019 mission to Havana, Cuba, an unforgettable experience which I repeated this spring without his presence. His fellows group have accepted me as one of their own, through them I will always be connected to this greatest of surgeon-scientists.

All this occurred because of an itch, a desire to learn, a decision to go beyond what I had always done, what was comfortable. It led to achieving a sense of absolute fulfillment for my career in orthopedics, and all of it was ordained by one incredible man. I was touched by greatness, and I knew it. Every moment of every day, I knew it. I let him know how absolutely grateful, thankful, and honored I was for this gift he was bestowing on me, 50, 100 times or more in our communications. He knew, but we both knew I was a gift for him at the exact right time he needed me. I never knew him well personally, visited him only once at USC and at AAOS and AAHKS meetings, all fairly brief and with a surprisingly professional bent but this didn't take away from the special bond we shared. His untimely passing has left a hole in my life that can never be filled but I told him my legacy would be carrying on and teaching what we discovered, through this we will always be united. I share this experience with readers that it might inspire other doctors, young and old, to take the leap and pursue something to the end of knowledge and then take just one more step. That step might make all the difference, that step might change your life too.

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