Giants in Orthopaedic Surgery

Giants In Orthopaedic Surgery: Robert Bruce Salter CC, MD, FRCSC

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A note From the Column Editor:

Like many medical students who trained before the Internet and the E-books, Dr. Salter's textbook, Textbook of Disorders and Injuries of the Musculoskeletal

Note from the Editor-in-Chief: In "Giants In Orthopaedic Surgery," a columnist explores the life and achievements of an orthopaedic surgeon who changed our profession, by interviewing other surgeons whose lives the "Giant" touched through mentorship or collaboration, or by using other historical sources that provide similar insight. We welcome reader feedback on all of our columns and articles; please send your comments to eic@clinOrthop.org.

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System [13] was my first formal introduction to orthopaedic surgery. Even professors outside of the orthopaedics department knew of this textbook's title and author, recommending it because of its clarity, completeness, and brevity. It proved a useful resource to many orthopaedic residents. Now, most medical students become acquainted with Dr. Salter not by his text, but from his pediatric fracture classification.

What may we learn from Dr. Salter today? He devoted his career to gain a better understanding of the mechanisms of orthopaedic trauma and disease. This insight led to the development of classifications improving diagnosis, better interventions, and clearly defined outcomes. His enduring commitment to patient care was inextricably linked to his focus on education and research.

In a career that spanned 55 years, Dr. Salter spent four decades at the Hospital for Sick Children, first as Chief of Orthopaedic Surgery and later as Surgeon-in-Chief. Much of his work remains highly relevant. The innominate osteotomy that

bears his name, his approach to developmental dysplasia of the hip, the use of continuous passive motion to promote articular cartilage and joint health, and the Salter-Harris fracture classification are his major contributions. These topics have provided the basis for clinical care and research studies, both in the basic science and clinical realms.

Fundamentally, Dr. Salter learned from his patients so he might improve their overall health and then pass this new-found knowledge onto the next generation of medical students and orthopaedic surgeons.

– Marlene DeMaio MD, MC,
Capt. USN (retired)
Clinical Professor, Department of Orthopaedic Surgery,
Marshall University

A New Approach to Hip Dysplasia

An engaging speaker, a charismatic professor, a loyal mentor, and of course, a proud Canadian—there is no shortage of words to describe Dr. Robert Bruce Salter (Fig. 1). In

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Fig. 1 Robert Bruce Salter CC, MD, FRCSC. (Published with kind permission of ©Hospital Archives, The Hospital for Sick Children, Toronto. 2014. All Rights Reserved.)

clinical orthopaedics circles, however, he is simply known as a world-renowned pediatric orthopaedic surgeon.

Dr. Salter is widely recognized for the innominate osteotomy, often referred to as the Salter osteotomy. He liked to call it, in a pun on the word innominate, the “no name, no fame osteotomy.” The corrective surgery addresses congenital dislocation and subluxation of the hip in patients older than 18 months up to young adulthood [5, 7, 14, 16]. The innominate osteotomy was also proven to be an effective surgical treatment for patients with Legg-Calvé-Perthes disease [15].

Dr. James G. Wright worked with Dr. Salter at The Hospital for Sick Children (SickKids, Toronto, Canada) in various capacities throughout his career. When Dr. Wright ascended to Surgeon-in-Chief at SickKids, he joked that he was essentially Dr. Salter’s boss—as if anyone could be his boss.

“I think he changed pediatric hip surgery,” Dr. Wright said in a phone interview with CORR®. “Prior to his entrance into practice in the mid-1950s, [development dysplasia of the hip] was a devastating disease and the treatment was as bad as, or worse, than the treated condition. He made this [osteotomy] a safe operation with good outcomes.”

Dr. Wright added that adoption of the innominate osteotomy took approximately 10 years in a field where acceptance of a new approach usually takes 30 to 50 years before it truly enters the mainstream. “His results were obviously so much better than what everyone else was doing,” Dr. Wright said. “That combination led to a change in management.”

Since the introduction of the innominate osteotomy more than 50 years ago, good results have been reported in long-term followup studies [6, 9], and the operative technique itself has not been substantially altered [16].

Although this procedure is considered a standard intervention in the management of development dysplasia of the hip, Dr. John Wedge, a close colleague of Dr. Salter’s at SickKids for many years, does not consider the innominate osteotomy to be his seminal achievement in orthopaedics. Instead, he considers Dr. Salter’s methodical approach to the management of children with dislocated hips more important than the osteotomy itself (Fig. 2).

“He developed a method that systematically, step-by-step, changed all of the components of the treatment of dislocated hips so that the treatment was gentle, it was logical, and it was carried out with technical precision,” Dr. Wedge said in a phone interview

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Fig. 2 Dr. Salter is widely recognized for the innominate osteotomy, often referred to as the Salter osteotomy. (Published with kind permission of ©Hospital Archives, The Hospital for Sick Children, Toronto. 2014. All Rights Reserved.)

with *CORR*®. “After working with Dr. Salter, I went to work with some other names in pediatric hip surgery and found that none of them carried the exactitude, the precision, the relentless pursuit of improvement of the management of the conditions he was working on.”

Changing Thought on Pediatric Fractures and Healthcare Quality

It was this “relentless pursuit of improvement” that led Dr. Salter, along with his colleague Robert Harris MD, FRCS, to the treatment of injuries involving the epiphyseal plate. Drs.

Salter and Harris devised a fracture classification system, known as the Salter-Harris classification system, which was “based on the mechanism of injury and the relationship of fracture line to the growing cells of the epiphyseal plate.” [12]. Recognizing epiphyseal plate injuries could cause significant complications for a child, Drs. Salter and Harris were among the first to take into account the location of the fracture with respect to the physis [1, 8]. Several complex pediatric fracture classification systems are currently available, but since its introduction in the 1960s, none have been as widely accepted as the Salter-Harris Classification system.

“The classification was based on a fundamental understanding of what the actual biological damage was to the growth plate with each fracture and in the gradation of the system, it more or less implied how it should be treated or if it could be treated,” Dr. Wedge said.

Immobilization Versus Movement: The Debate Continues

Unlike the innominate osteotomy, which is still producing good long-term results, or the widely accepted Salter-Harris classification system, Dr. Salter’s concept of continuous passive motion (CPM) has become somewhat controversial. The concept challenged the long-held notion of treating diseased and injured joints through immobilization, limiting the ability for joint cartilage regeneration [14]. Instead, he introduced and carefully studied CPM, arguing that synovial joints were meant to move, and that motion provided nutrition to the joint surface [2, 11].

“I originated the (then new) biological concept of CPM of joints after making 23 experimental and clinical observations including the deleterious effects of immobilization of joints,” Dr. Salter wrote in an editorial for *The Journal of Rheumatology* in 2004 [11]. “Thus, CPM is a concept, not just ‘a motorized device.’”

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In 1978, Dr. Salter used CPM to treat adult patients with varying joint disorders and injuries [11]. These early clinical applications provided promising results: CPM was well-tolerated, provided normal wound healing, reduced complications, and shortened hospital stays and rehabilitation duration [2]. Based on the results of his 27 total research projects, Dr. Salter recommended 13 indications [11]. It is estimated that more than 9 million patients have been treated with CPM worldwide [14]. However, the immobilization versus movement debate continues. Recent studies have found that CPM offers no benefit in intra-articular fractures [4] or TKA [3] in the long-term.

A Dedicated Researcher

Dr. Salter's body of work reveals an insightful mind, and a nose for quality studies and research practices. In an open letter to the Canadian Orthopaedic Association, Dr. Salter wrote: "As an orthopaedic clinician/scientist for 50 years, I am well aware that the difference between a good orthopaedic division and a truly great orthopaedic division is the presence in the latter of a strong and effective programme of original research—both clinical and experimental. We owe it to our patients to continue improving our

methods of diagnosis and treatment through exciting research and thereby producing a significant legacy for the entire specialty of orthopaedics" [10].

Another aspect of Dr. Salter's legacy is what he termed the Cycle of Medical Research; a 16-step series that begins and ends with the patient [10]. "This cycle exemplifies clinically relevant research that is designed to find the solution to an unsolved clinical problem and, when appropriate, to apply the new knowledge to the prevention, diagnosis or treatment of the original problem," he continued in the letter [10].

Dr. Peter F. Armstrong, who was Dr. Salter's fellow at SickKids, explained that he was a proponent of how research and clinical practice are inextricably linked. "You have to always be looking at it with a critical eye," he said in a phone interview with *CORR*[®], adding that Dr. Salter "was very big on instructing the medical students, residents, and fellows on the research cycle, which was all tied into clinical practice."

A Consummate Educator

In addition to a keen eye, Dr. Salter's colleagues say he was incredibly articulate and charismatic and able to take complex concepts and make them understandable and approachable for

everyone—from the medical student up to the senior clinician.

"That's one of the things I came to appreciate," Dr. Wright said. "It wasn't just the insight or the discovery; it was his ability to package that information, transmit it, and engage the audience in a way that few others were able."

According to Dr. Wright, Dr. Salter had a specific focus on education, and he was particularly captivated by medical students. He possessed endless patience for medical students, which stimulated him to write a book for them: *Textbook of Disorders and Injuries of the Musculoskeletal System* [13]. For many medical students, this text was their first introduction to orthopaedics.

"I think he took that responsibility to heart," Dr. Wright said.

Former fellows and attending staff from SickKids reciprocated their appreciation by establishing The Salter Society [1]. The society has grown to more than 300 members. They meet annually to share achievements inspired by his teaching and mentoring. The University of Toronto annually awards the R. B. Salter Award for Excellence in Orthopaedic Education in recognition of his teaching abilities [1]. The SickKids Foundation, which raises funds on behalf of The Hospital for Sick Children, established the SickKids Robert

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Fig. 3 Dr. Salter was inducted into The Canadian Medical Hall of Fame in 1995. (Republished with permission from The Canadian Medical Hall of Fame and Irma Coucill.)

Salter Humanitarian Award. The award annually recognizes a SickKids staff member for their compassion and humanitarianism. And in 1995, Dr. Salter was inducted into The Canadian Medical Hall of Fame (Fig. 3).

Lifelong Relationships with Patients

Dr. Salter did more than inspire generations of orthopaedic surgeons; he also developed meaningful relationships with his patients. As a pediatric

orthopaedic surgeon he was offered a unique chance to see how these patients progressed over time both for the purposes of medical research and as a friend.

“One of his most famous [lines] was ‘friends for life,’” Dr. Armstrong said. “All of his patients were friends for life and he developed incredible relationships with the kids and their parents.” “He was the role model for being a gentleman in all aspects of things. You wanted to learn not necessarily to be like him, because we all have our own

individual characteristics, but you saw so many things about him that you respected and helped you, not just develop as a skilled surgeon in a particular area, but as a better person.”

References

1. American Academy of Orthopaedic Surgeons. Growth plate fractures. Available at: <http://orthoinfo.aaos.org/topic.cfm?topic=A00040>. Accessed July 21, 2014.
2. Biological concept of CPM. Available at: <http://www.continuouspassivemotion.org/Pages/Biologicalconcept.htm>. Accessed August 5, 2014.
3. Harvey LA, Brosseau L, Herbert RD. Continuous passive motion following total knee arthroplasty in people with arthritis. *Cochrane Database Syst Rev*. 2014;2:CD004260.
4. Hill AD, Palmer MJ, Tanner SL, Snider RG, Broderick JS, Jeray KJ. Use of continuous passive motion in the postoperative treatment of intra-articular knee fractures. *J Bone Joint Surg Am*. 2014;96:e118.
5. Infant and child hip dysplasia. Osteotomy. Available at: <http://hipdysplasia.org/developmental-dysplasia-of-the-hip/child-treatment-methods/osteotomy/>. Accessed August 5, 2014.
6. Liu TJ, Shi YY, Pan SN, Liu ZJ, Zhao Q, Zhang LJ, Ji SJ. Evaluation of mid-term follow-up after Salter innominate osteotomy in developmental dysplasia of the hip [in Chinese]. *Zhonghua Wai Ke Za Zhi*. 2010;48:1149–1153.

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7. Martin S. Toronto doctor helped children overcome devastating injuries. *The Globe and Mail*. June 11, 2010.
8. National Institute of Arthritis and Musculoskeletal and Skin Diseases. Questions and answers about growth plate injuries. Available at: http://www.niams.nih.gov/Health_Info/Growth_Plate_Injuries/default.asp#-box_2. Accessed July 6, 2014.
9. Robb CA, Datta A, Nayeemuddin M, Bache CE. Assessment of acetabular retroversion following long term review of Salter's osteotomy. *Hip Int*. 2009;19:8–12.
10. Salter RB. An open letter to fellow members of the Canadian Orthopaedic Association from Dr. Robert Salter. COA Bulletin. February/March 2005. Available at: http://www.canorth.org/en/pdfs/Salter_an.pdf. Accessed July 7, 2014.
11. Salter RB. Continuous passive motion: From origination to research to clinical applications. *J Rheumatol*. 2004;31:2104–2105.
12. Salter RB, Harris RW. Injuries involving the epiphyseal plate. *J Bone Joint Surg Am*. 2001;83:1753.
13. Salter RB. *Textbook of Disorders and Injuries of the Musculoskeletal System*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins; 1999.
14. SickKids. Remembering Dr. Robert Salter. Available at: <http://www.sickkids.ca/AboutSickKids/Newsroom/Past-News/2010/dr-robert-salter.html>. Accessed July 8, 2014.
15. Thompson GH. Salter osteotomy in Legg-Calvé-Perthes disease. *J Pediatr Orthop*. 2011;31(2 Suppl):S192–197.
16. Wedge JH, Salter RB. Video journal of orthopedics. Salter's innominate osteotomy after 45 years. Available at: <http://www.vjortho.com/2008/06/salters-innominate-osteotomy-after-45-years>. Accessed August 20, 2014.