

To MOON and Back

Lessons Learned and Experience Gained Along the Way



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KEYWORDS

• MOON • knee • Prospective cohort • Multicenter • Outcomes ACL

KEY POINTS

- The Multicenter Orthopaedic Outcomes Network (MOON) is one of the largest prospective cohorts in orthopaedic sports medicine, with more than 4,000 anterior cruciate ligament reconstructions (ACLRs) enrolled.
- Bringing the dream of MOON to fruition took more than a decade of planning. Among many topics, this article describes the early cohort studies that ultimately paved the way for MOON.
- When working with teams of researchers, it is vital to demonstrate that the data collected by different individuals is scientifically valid. This article also reviews the agreement studies done in preparation for MOON.
- Conducting multicenter orthopaedic research requires a large and diverse team, with individuals of different backgrounds and areas of expertise including physicians, epidemiologists, biostatisticians, physical therapists, research coordinators, and many more.
- Although conducting multicenter orthopaedic research is challenging, the story of MOON provides many valuable lessons that can help those aiming to design or participate in multicenter research.

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“That’s one small step for man, one giant leap for mankind.”

These words were immortalized by Neil Armstrong as he stepped out of the lunar module Eagle in the summer of 1969, marking the successful culmination of the Apollo space program and the fulfillment of the late President John F. Kennedy’s 1961 promise to land a man on the moon before the end of the decade. Given that only a few months had elapsed between Russian cosmonaut Yuri Gagarin’s maiden voyage into space and President Kennedy’s promise, some might have considered the president’s goal impossible. Today, some might refer to such a promise as a BHAG – a big, hairy audacious goal – a term coined by James Collins and Jerry Porras in their 1994 book *Built to Last: Successful Habits of Visionary Companies*. It took only a mere 9 years from the first human trip into space until Armstrong and Aldrin’s famous moon walk. Needless to say, there were countless hours poured into planning the Apollo 11 mission, and equally as many hurdles to overcome in order to make President Kennedy’s dream a reality. Much like Apollo 11, the story of MOON is one of vision, teamwork, perseverance, and (thankfully) success. And, also like Apollo 11, MOON’s (Multicenter Orthopedic Outcomes Network) story began long before its official launch, with more than a decade of thought and planning preceding the enrollment of the first study participant in 2002.

The journey to the MOON really began during one author’s fellowship year at Cleveland Clinic in 1990, a full 12 years before the authors enrolled their first patient into what has now become the largest prospective anterior cruciate ligament reconstruction (ACLR) cohort with at least 80% follow-up in the world. The story starts with a much smaller prospective cohort study involving a mere 54 patients who had undergone acute (within 3 months of injury) ACLR at Cleveland Clinic during the year of that fellowship.¹

At the time, it was well established that knees undergoing primary ACL repair had a high failure rate by their fourth postoperative year, and it was beginning to be realized that ACL reconstruction utilizing an autograft led to a more anatomically stable knee while also reducing the incidence of subsequent meniscus tears. In addition, chronic ACL deficiency seemed to be associated with both worse outcomes and the development of post-traumatic osteoarthritis.^{2–5} Additionally during this time period, a growing body of literature suggested that ACL reconstruction improved knee stability and function, at least in the short term (2 years after surgery).⁶ However, what remained largely unknown and at the forefront of many orthopedic sports medicine surgeons’ minds was, given the myriad of associated injuries that concomitantly occurred at the time of an ACL tear (eg, meniscus tears, articular cartilage injuries, and bone bruises), which types of injuries or treatments were predictive of clinically relevant outcomes. Furthermore, whether ACLR decreased the incidence of future post-traumatic osteoarthritis was unknown. Thus, beginning in the fall of 1990, the authors enrolled 54 patients with the goal of determining the association between bone bruises seen on MRI and meniscus and articular cartilage injuries. In addition, the authors hoped to follow this cohort for 10 years to shed some light on longer term outcomes. The authors were naïve to believe that they could determine which preoperative and intraoperative variables (specifically the presence of bone bruising and/or meniscus or articular cartilage injuries) could be used to predict long-term outcomes in such a small dataset.^{1,7}

It did not take long for the authors to realize that there were likely a multitude of variables beyond intra-articular injuries that impacted both the development of post-traumatic osteoarthritis and long-term patient-reported outcomes measures (PROMs). Furthermore, with the increased utilization of ACL reconstruction rather than the traditional repair, new and important questions arose that also needed answering such as what graft to use (autograft or allograft, hamstring or bone-

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