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CORR Insights

# *CORR* Insights®: How Much Clinical and Functional Impairment do Children Treated With Knee Rotationplasty Experience in Adulthood?

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## Where Are We Now?

While it remains both a complex and rarely performed procedure, rotationplasty remains an important component of the surgical armamentarium of musculoskeletal oncologists and pediatric orthopaedic surgeons. Benedetti and colleagues [1] performed gait, radiographic, and functional analysis on 25 volunteer patients out of a cohort of 31 osteosarcoma survivors at a mean of 15 years following rotationplasty, making their study one of the largest, with the longest postoperative followup, to date. As they appropriately state, in properly selected patients, rotationplasty "may offer functional advantages over transfemoral amputation and more durable results than a prosthesis" [1]. From an oncologic perspective, both limb salvage and rotationplasty have become widely accepted alternatives to transfemoral amputation or hip disarticulation for treatment of osteosarcoma about the knee due to the absence of an apparent survival benefit with more proximal amputation [7]. The four critical criteria that must be met before undertaking a rotationplasty include: (1) The presence of a functionally competent ipsilateral ankle, (2) tumor sparing of the sciatic nerve, (3) adequate local prosthetic infrastructure to achieve the putative benefits of the procedure and, critically in many cases, (4) patient and family

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willingness to undergo rotationplasty after detailed counseling.

We know what happens next, as the short- and intermediate-term results of rotationplasty have been well documented [3, 5, 8]. But what happens much later? The findings of Benedetti and colleagues [1], as well as others [3, 5, 8], suggest that the functional results are pretty good, with Musculoskeletal Tumor Society Scores averaging 25 in this report, which is good and potentially better than historic data following limb salvage or amputation [6], and seem to be sustained over time. Also, near-normal gait kinetics and kinematics at adulthood are achievable following rotationplasty, and achieving as near to equivalent as possible knee center axis of rotation at skeletal maturity may be important both functionally and cosmetically. We know also that the rotated foot will end up somewhat smaller. Finally, and most importantly, radiographic evidence of rotated hindfoot and ankle arthrosis becomes more common with increasing followup [1, 3], which may further explain a decrease in rotated ankle ROM over time.

## Where Do We Need To Go?

Given equivalent oncologic results when limb salvage is performed using an endoprosthesis, transfemoral amputation, or rotationplasty, the questions then become those of function, quality of life, and reconstructive (rather than oncologic) longevity. In the absence of neurovascular involvement necessitating an amputation, there usually is not necessarily a "wrong" approach here, but arriving at the ideal treatment strategy is not easy; there are pros and cons with each procedure. Limb salvage patients get to keep their native extremity, appear cosmetically more "normal," and perform most activities of daily living without the need for a conventional or specialized prosthesis. This convenience comes at the expense of long-term concerns regarding eventual revision surgery either at skeletal maturity (for a growing prosthesis) or later due to implant loosening, wear, or other kinds of implant failure, with further functional compromise typically following each surgical revision. Both amputation and rotationplasty require an external prosthesis, and all of the hassles, costs, and inconveniences that this implies, for daily ambulation. Conversely, successful amputation and rotationplasty patients are essentially limited only by what they can learn to do in their prostheses, and contact athletic competition or high-impact recreational sport participation represent often-achievable goals [5]. Many endoprosthesis patients cannot do these things and the rest, frankly, probably should not.

Likewise, the long-term secondary health effects of amputation, ranging from degenerative joint disease and lower back pain to cardiovascular disease and obesity, have been well documented [2]. Similar data are not readily available following rotationplasty or pediatric limb salvage, but one could anticipate that these patients are also probably not "normal." The most concerning finding of Benedetti and colleagues [1] was the increasing prevalence of ankle and hindfoot arthrosis and concomitant gradual decrease in rotated ankle ROM. These arthritic findings were radiographic, rather than clinically symptomatic, at least for now; the average age of these patients at long-term followup was all of 24 years.

Eventual decline in function seems inevitable. In theoretical terms, what we need are truly durable reconstructions that will last our pediatric patients well into middle age, rather merely getting them through adolescence and early adulthood with reasonably, some would say remarkably, good function, and quality of life [4, 8]. However, such ageless and durable reconstructive alternatives are not readily forthcoming. Indeed, one could argue that, as the rest of us peak physically in early adulthood, how can we expect our oncologic patients to fare any differently? A more practical goal, then, is to adequately and accurately determine what happens to these patients as they age further.

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**How Do We Get There?**

The answer here seems fairly simple to me. We need continued and additional long-term studies (and by long-term, I mean 20, 30 or 40 year followup) of patients in all three of these treatment cohorts. As always, this is easier said than done, and the usual hurdles and caveats exist. However, it is becoming increasingly easy to locate "lost" patients in the digital age. Despite changes in implant design, conventional total joint arthroplasty practices continue to be usefully informed by the long-term results of devices no longer in use. And we can easily argue that the rotationplasty patients we most need to follow have had their surgery performed many years ago.

The work by Benedetti and colleagues [1] portends declining function for these patients in the future. How well will a rotationplasty function with symptomatic ankle arthritis and limited motion? Is total ankle arthroplasty even a reasonable or realistic consideration in these patients as they approach middle age? The typical alternative to arthroplasty for arthritic native ankles, arthrodesis, certainly sounds like a horrible idea.

The point, then, is this: As patients who have undergone either rotationplasty, amputation, or limb salvage for malignant tumors about the knee age, their function and quality of life will most likely continue to decline, just as it does for all of us. At some point(s), however, their respective functional capabilities, gait characteristics, and health-related quality of life will either diverge further from or converge closer to that of the other treatment cohorts. Determining where (or, more accurately, when) these inflection points are, what the functional implications of them are, and what happens after represents the best way to help us both counsel our patients today and improve our reconstructive options in the future.

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