Bone sarcomas are the fourth most common cancer in individuals under 25 years. Osteosarcoma is the most common form of sarcoma in this population and is commonly observed in the rapidly growing metaphyseal areas of extremity long bones.

The primary consideration is always the capacity to achieve a wide resection with clear surgical margins, leaving the different modalities of reconstruction to be practised as secondary considerations. Some prostheses function better than others in different joints leading to favoured techniques for different resections types. The distal femur is an obvious case of an excellent functional reconstruction compared with amputation. As time progresses the two recent major surgical voids of the proximal tibia and the shoulder joint are also improving with prosthesis and encircling mesh attachments. In general the lower limb is much more amenable to prosthetic reconstruction and allows good ambulation with some limitations, albeit vastly better than amputation. The upper limb, although not quite as readily reconstructed with a good outcome functionally by contemporary standards, does better due to the fact that “any arm is a good arm” to allow limited grasp and pinch either in the hand or the against the chest wall.

Pelvic resections and the required reconstructions pose major long term viability problems with many of the available reconstructive options, all of which have an initial success rate of approximately 30%, requiring further reconstructions. There has been a recent groundswell of activity with regards to non-reconstruction and production of a pseudoarthrosis, due to the long-term failure of most of these options. Diaphyseal resections of mid segments of bone generally do well with availability of fibula direct transfer, prosthetic segments, or bone distraction techniques such as the Ilizarov frame, allowing for a diverse array of treatments. Below the mid tibia very few simple options exist except amputation, although the aggressiveness of the disease and the advent of plastic surgical soft tissue flaps have widened the reconstructive options and helped with avoidance of amputation. Current options for limb reconstruction after sarcoma include amputation, rotationplasty, arthrodesis and arthroplasty.

Rotationplasty is an operation where the foot is placed backwards on the knee and is ideal for the ages of six to nine. It is not well accepted in western society, however, is still popular in low resource countries that struggle to afford contemporary prosthetic options. See figures one and two.

Figure 1: Rotationplasty intraoperative surgical technique.

Figure 2: Final result Rotationplasty with below knee prosthesis.
Arthrodesis, or fusion of the affected joint, is practised less and less, however, as it still carries the risk of the shoulder and the pelvis where prosthetic options are limited.

Artroplasty or joint replacement is most popular with the use of a mega-prosthesis, either in isolation or with allograft. Reconstruction of a limb to near normal physical appearance is possible, but there are ambulatory functional limitations. See figure three.

## Findings

Limb salvage patients demonstrated prolonged rectus femoris activation in both their affected and unaffected lower limbs when compared with the control participants. Limb salvage patients also displayed significantly prolonged activation of the medial hamstrings and the medial gastrocnemius in their affected lower limb when compared with the control subjects. The medial hamstrings activity was observed to be significantly longer in their affected lower limb when compared to their unaffected lower limb. Assessment of rectus femoris/medial hamstrings co-contraction showed that limb salvage participants had a higher quadriceps to hamstrings co-contraction index in both lower limbs when compared to the control subjects, with their affected lower limb showing a trend for a higher index compared to their unaffected lower limb.

There were no group differences in free walking velocity or relative velocity. Gross energy expenditure, net energy expenditure and energetic cost measurements were all significantly higher in the limb salvage participants. Furthermore, mass specific values of energy consumption and cost of transport were significantly higher in the limb salvage participants.

Relative walking efficiency for the limb salvage population was calculated as 80%. Mass-specific net cost of transport was higher in the limb salvage participants compared to the control participants, for a given relative velocity. The ANOVA test analysis (Analysis Of Variance) confirmed the difference between the heights of the two slopes (p < 0.001) but not the gradient. Pearson correlations showed negative relationships between knee extension strength (R = -0.46, p < 0.05) and energy cost. Furthermore, Pearson correlations showed positive relationships between knee extensor strength and rectus femoris activation time (R = 0.39, p < 0.05) and between knee extension strength and rectus femoris co-contraction percentage (R = 0.43, p < 0.05). Time from surgery was not related to any of the electromyographic or energetic parameters assessed. Finally, Pearson correlations revealed that there were small but insignificant relationships between the electromyographic findings and the energetic results.

## Conclusion

Prolonged activation patterns were observed in muscles surrounding the knee in total knee replacement patients. As a typical total knee replacement stiff-legged gait pattern was adopted, the prolonged activations were not related to increased moment requirements, suggesting that the activity patterns were related to knee stability and may have reflected proprioceptive deficits at this site. Electromyographic patterns in the unaffected lower limb suggested that alterations in gait involved higher neuronal centres. These results are important for the development of rehabilitation programs, as they suggest that an overall reprogramming of the gait pattern occurs post-operatively, partly limiting the impact of conventional strength and stretching interventions.

On consideration of quality of life factors, limb salvage alone versus amputation has significant value in allowing the person to maintain their ambulatory independence. On a low functional level with activities of daily living, ambulatory independence has returned without crutches and the ability to walk up and down stairs and long distances. At a higher functional level many return to sport with an appropriate disability grading for active competition.

Prosthetic reconstruction is not a normal limb, but much closer to normality in any other reconstructive option, with some added increased physical oxygen demands due to heightened muscle activity.

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**References**