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The Effect of Total Knee Arthroplasty on Active Knee Extension During Treadmill Walking

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Summary:
Determination of whether patients who receive full extension following a TKA use this full range of motion when they commence pain-free walking post-operatively.

Abstract:
Background
Fixed flexion contracture of the knee due to osteoarthritis is common in patients requiring a total knee arthroplasty (TKA). This is detrimental to overall knee function and increases energy expenditure during walking. Individuals may also consciously limit extension during walking to minimize pain or avoid joint instability. TKA is a well-established procedure for restoring extension, however there is a suspicion that despite receiving a knee capable of achieving full extension, patients do not utilise this capability post-operatively. The purpose of this study was to determine whether patients who receive full extension following a TKA use this full range of motion when they commence pain-free walking post-operatively.

Materials & Methods:
Gait analysis of patients undergoing unilateral TKR was conducted prior to surgery and repeated when they commenced pain-free locomotion. A high-speed optoelectronic camera system (200Hz, Vicon Bonita/Nexus, UK) was used to record maximum knee extension of the operated limb during standing and while supine (passive knee extension), step-descent onto the injured limb from a 20cm high step, as well as treadmill walking at both a self-selected comfortable speed and 130% ("fast") of that speed for one minute each. Student t-tests were used to compare differences between pre-operative and post-operative values for the cohort aggregated and for each patient (single-case).

Results:
A cohort of 24 patients (15 females; 70.8±6.5yrs; 168.8±8.9cm; 84±13.2kg) was assessed before, during and 4.7 ±0.5months after surgery. On average, patients displayed fixed flexion preoperatively during the passive supine measurement (14.7°, 12.8-19.3), did not fully extend during the step-descent (14.9°, 17.3-13.9) or during treadmill walking at both self-selected comfortable (17.6°, 20.8-13.8) and fast (17.1°, 20.2-13.9) speeds. Postoperatively, fixed flexion during the supine measurement improved significantly ($P<0.01$) to 3.7° (1.6 – 5), however 33.3% of knees exhibited >5° flexion and 58.3% exhibited >3°. The use of knee extension increased significantly, on average, for standing, stepping and walking. Single case comparisons indicated that for the stepping task, all but 3 patients significantly improved the maximum extension value during the post-operative assessment ($p < 0.05$). For the comfortable and fast walking tasks, all patients achieved a significantly ($p < 0.05$) greater maximum extension angle. However, the majority of patients (75-92%) used significantly ($P<0.05$) less extension during locomotion compared to the passive supine measurement, and minimum knee flexion during walking remained significantly higher than for healthy geriatric populations.

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Conclusions:
TKR patients utilise improved extension during passive measurement and locomotion following surgery. The amount of improvement did not differ across the functional tasks. However, patients did not utilise the full amount of extension restored intra-operatively. These results highlight the importance of focused rehabilitation during the post-operative period aimed at optimising extension during gait, in order to achieve the best functional outcome.