QUADRICEPS EMG DURING WEIGHTED KNEE EXTENSION FOLLOWING TOTAL KNEE ARTHROPLASTY

Jeannette M. Byrne¹ and Stephen D. Prentice²

¹Assistant Professor, School of Human Kinetics and Recreation, Memorial University of Newfoundland, St. John’s, Newfoundland, jimbyrne@mun.ca
²Associate Professor, Department of Kinesiology, University of Waterloo, Waterloo, ON

INTRODUCTION

Total knee arthroplasty (TKA) results in decreased pain and improved function. Despite these improvements, deficits in knee function persist after surgery. Research has shown persistent decreases in knee extensor moments during gait (Benedetti et al 2003) and stepping tasks (Byrne et al 2002). Altered knee kinematics has also been reported (Byrne et al 2002; Wilson et al 1996). More recent research has examined muscle activation following TKA, finding deficits in both EMG timing (Benedetti et al 2003) and amplitude (Mizner and Snyder-Mackler 2005).

A question that remains unanswered is whether the changes in joint kinematics and kinetics observed in this population are secondary to some underlying alterations in muscle function or whether the changes observed in EMG are simply indicative of the altered movement patterns exhibited by this patient group. In an effort isolate the effect of TKA on muscle function, EMG was recorded from knee muscles while individuals (with and without TKA) performed a seated knee extension. This task was chosen as it enabled the kinematic and kinetic demands to be controlled, ensuring that both groups were exposed to similar conditions.

METHODS

Two groups of individuals were examined in this study. The first group consisted of 6 individuals (mean age=71 years, SD=10) who had undergone unilateral knee joint replacement at least one year previous to testing (actual times post-op: 31, 25, 26, 19, 19 and 72 months). The second group consisted of age matched controls (mean age =70 years, SD=4) with no history of knee injury. EMG was recorded from vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF), medial and lateral hamstrings, and medial and lateral gastrocnemius using a Bortec EMG system. Data were sampled at a rate of 1200Hz and bandpass filtered (10Hz – 500Hz) prior to being digitally sampled. All subjects were seated in a chair that allowed them to fully flex and extend their knee without restriction. During all trials the hip was positioned at 90º. Subjects completed a total of 18 knee extension trials during which they were instructed to fully extend their knee from a flexed position. Trials consisted of six weight conditions: extension with no weight, and knee extension with weights of 1.1 kg, 2kg, 2.9kg, 3.8kg or 4.7kg attached to the ankle. Temporal feedback was provided to ensure that all participants
completed the task in the same amount of time.

EMG data were first full-wave rectified, linear enveloped and normalized to a maximum contraction. EMG signals were then integrated (trapezoidal rule) for the time period from the start of knee extension until full extension was reached. Average integrated EMG (AiEMG) was determined by dividing iEMG by the total time it took to complete the knee extension trial. A two-way repeated measures ANOVA (1 repeated factor (weight) and 1 between subject factor (control or patient)) was then performed on the AiEMG measures.

RESULTS

Patients had significantly greater AiEMG than controls for both VM (p=0.048) and VL (p=0.0197). Rectus femoris exhibited a similar trend, although it did not reach significance (Figure 1). No statistically significant differences existed between the groups for the other muscles. All interaction effects were non-significant. The time to complete the task was 2.3s. Time did not differ significantly either between the groups or across weight conditions.

Figure 1: AiEMG for VM, VL and RF during seated knee extension for patient and control groups. (* and ** significant difference between patient and control for muscle indicated.)

DISCUSSION

Preliminary analysis of this data found that following TKA, individuals activate VM and VL to a greater extent then do age matched controls. Activation levels of the hamstrings and gastrocnemius, the other primary muscles crossing the knee joint, showed no differences between the groups. Because the seated knee extension task requires the same gross knee kinematics and places similar kinetic demands on the knee, the observed changes in muscle activation may be attributed to alterations in muscle function. While muscle weakness is one factor that must certainly be considered, alteration in muscle moment arms may also contribute. Further research is underway to examine these issues.

SUMMARY

The current study examined AiEMG during a seated knee extension task in individuals following TKA. Findings indicate increased AiEMG in VL and VM in the patient group.

REFERENCES