

Differential analysis of muscle fatigue induced elbow and wrist tremor in controlled laparoscopic manoeuvring

Sourav Chandra, Mitsuhiro Hayashibe, Asokan Thondiyath , Manickam Ramalingam

First published: 20 September 2016 [Full publication history](#)

DOI: 10.1002/rcs.1772 [View/save citation](#)

Cited by [CrossRef](#): 0 articles [Check for updates](#) [Citation tools](#)



[Funding Information](#)



[Browse Early View Articles](#)
Online Version of Record
published before inclusion
in an issue

Abstract

Background

Fatigue induced hand tremor (FIT) is a primary limiting concern for the prolonged surgical intervention in minimally invasive surgery (MIS) and robot-assisted-minimally invasive surgery (RAMIS). A thorough analysis is necessary to understand the FIT characteristics in laparoscopic tool movement. The primary aim of this study is to perform a differential analysis of the elbow and wrist tremor due to muscle fatigue in laparoscopic manoeuvring.

Methods

We have introduced a joint angle based tremor analysis method, which enables us to perform a differential study of FIT characteristics at the individual joint. Experimental data was acquired from a group of subjects during static and dynamic laparoscopic movement in an imitative RAMIS master manipulation scenario. A repetitive task was performed with a total span of 1 h for observing the effect of muscle fatigue. Along with the joint angle variation, surface electromyography (sEMG) signal was also studied in the analysis.

Results

The wrist tremor is more predominant than tremor generated at the elbow, especially in highly fatigued condition. The high-frequency tremor (>4 Hz) is contributed by the wrist joint. Moreover, the variation of the wrist and elbow tremor ratio was found to be dependent upon the experience of the surgeons.

Conclusions

In this work, we have investigated the attribution of elbow and wrist joints in FIT during laparoscopic tool manipulation. The outcomes may be useful for the design of robot-assisted surgical manipulator, and can be used for quality assessment of surgical training as well.