Cutting ultra-thin bio-tissue sections in a hybrid microtome

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Abstract

Introduction

Modern day microtomy requires improved cutting efficiency – by increasing the number of high precision cuts possible from a single cutting blade. In microtomy, the quality of sections is directly related to the quality of the blade, the hardness of the tissue sample, cutting angle, temperature and speed of cuts made with the microtome.

Objectives & Methods

Theoretical and experimental results show that reduced cutting forces could be achieved in hybrid machining processes such ultrasonically assisted machining, in which high frequency vibrations are superimposed on a cutting tool to alter a conventional machining process into a micro-chipping one. The technique has been successfully used to demonstrate improved machinability of hard to cut materials such as Ti-alloys.

For next generation of microtomes a unique approach of employing controlled ultrasonic vibration on the blade may be implemented to process bio-tissues. It is hoped that with the introduction of an ultrasonic vibrations on the cutting device a reduction in the cutting force and thus blade wear could be achieved with improved section quality.

Results and Discussion

An ultrasonically assisted cutting device (UACD) was designed and manufactured for cutting thin sections of biological tissues. Experimental results on comparisons of cutting forces, blade wear and section qualities between conventional cutting and ultrasonically assisted cutting show that UACD is capable of providing extremely thin sections down to 4 µm in a controlled and repeatable way with reduced cutting forces and blade wear and improved section quality thus allowing for lower costs and improved efficiency in histology.