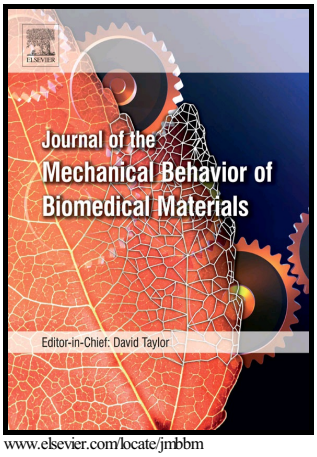
Study on design and cutting parameters of rotating needles for core biopsy

Marco Giovannini, Huaqing Ren, Jian Cao, Kornel Ehmann



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Marco Giovannini, Huaqing Ren , Jian Cao , Kornel Ehmann

Northwestern University 2145 Sheridan Road, Evanston, IL 60208

marcogiovannini2013@u.northwestern.edu
huaqingren2013@u.northwestern.edu
jcao@northwestern.edu
k-ehmann@northwestern.edu

ABSTRACT

Core needle biopsies are widely adopted medical procedures that consist in the removal of biological tissue to better identify a lesion or an abnormality observed through a physical exam or a radiology scan. These procedures can provide significantly more information than most medical tests and they are usually performed on bone lesions, breast masses, lymph nodes and the prostate. The quality of the samples mainly depends on the forces exerted by the needle during the cutting process. The reduction of these forces is critical to extract high-quality tissue samples. The most critical factors that affect the cutting forces are the geometry of the needle tip and its motion while it is penetrating the tissue. However, optimal needle tip configurations and cutting parameters are not well established for rotating insertions. In this paper, the geometry and cutting forces of hollow needles are investigated. The fundamental goal of this study is to provide a series of guidelines for clinicians and surgeons to properly select the optimal tip geometries and speeds. Analytical models related to the cutting angles of several needle tip designs are presented and compared. Several needle tip geometries were manufactured from a 14-gauge cannula, commonly adopted during breast biopsies. The needles were then tested at different speeds and on different phantom tissues. According to these experimental measurements recommendations were formulated for rotating needle insertions. The findings of this study can be applied and extended to several biopsy procedures in which a cannula is used to extract tissue samples.

KEYWORDS

Needle insertion, core needle biopsy, tissue cutting, cutting edge geometry, needle rotation.