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Review Article | Journal of Rheumatology and Arthritic Diseases | Open Access

Needle versus Forceps Technique in Ultrasound-Guided Synovial Biopsy of the Knee Joint

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Received: December 29, 2016; Accepted: April 4, 2017; Published: April 17, 2017

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Abstract

Objectives: Ultrasound-guided synovial biopsy is increasingly applied in rheumatology. Usually forceps- or needle-based techniques are used. So far there has been no direct comparison of different devices regarding their suitability in high resolution musculoskeletal ultrasound (hrMSUS)-guided synovial biopsy.

Methods: A core needle biopsy (Quickcore, Cook Medical, Bloomington, IN, USA), an anterograde arthroscopy forceps (Karl Storz GmbH, Tuttlingen, Germany), a retrograde forceps (Retroforce, Karl-Storz GmbH Tuttlingen, Germany) and an convexly shaped integrated core needle system (Synovex, Hipp Medical, Kolbingen, Germany) were tested for ultrasound-guided synovial biopsy of the suprapatellar recess in cadaver knee joints. Four senior rheumatologists scored each intervention from 0-5 regarding the following characteristics: visualization, handiness, accuracy, synovial tissue yield, invasiveness and overall suitability. Each intervention was recorded as static images and video clips.

Results: In all devices, enough representative synovial tissue was obtained and the instruments were all well visualized by hrMSUS. Core needle biopsy and the integrated needle system were best visualized due to their horizontally shaped closing mechanism. The core needle obtained a high yield of superficial synovial tissue and was the least invasive procedure. Despite handiness and accuracy were higher in the forceps instruments, overall suitability for hrMSUS -guided synovial biopsy was rated highest for the core biopsy needle.

Conclusion: Technically, all of the tested devices can be used for hrMSUS-guided synovial biopsy. Core needle biopsy seems to be most suitable for this intervention due to a low invasiveness, good visualisation and optimal yield of superficial synovial tissue.

Keywords: Synovial Biopsy; Ultrasound; Ultrasound-Guided; Forceps; Needle; HrMSUS; Core Biopsy; Retrograde Biopsy; Synoviti;

Introduction

Synovial biopsies can be required for the diagnosis of various rheumatic or metabolic disorders such as inflammatory arthritis, sarcoidosis, amyloidosis, chondromatosis or hemochromatosis which can be undetectable by serology, arthrocentesis or magnetic resonance imaging [1]. Histological evaluation is the method of choice in diagnosis of undifferentiated arthritis and remains gold standard for the assessment for the inflammation grade in arthritis [2]. In septic arthritis or periprosthetic joint infection, synovial biopsy has a higher diagnostic sensitivity and specificity compared to synovial fluid aspiration alone [3]. Synovial biopsy is commonly performed during arthroscopy, an invasive procedure that requires general or spinal anaesthesia. Historically, synovial biopsy has been done by blind needle biopsy e.g. using a Parker Pearson needle [4]. A new retrograde synovial biopsy device has recently been developed which can be applied without concomitant imaging [5]. Today, ultrasound-guidance is increasingly applied for synovial biopsy, as summarized by Lazarou et al. [6]. Visualization of the procedure by high resolution musculoskeletal ultrasound (hrMSUS) increases its precision, safety and diagnostic reliability as hypertrophic synovial lesions can be detected and targeted for biopsy e.g. in rheumatoid arthritis both in small and large joints [7]. HrMSUS currently is performed either by a forceps- or a needle-sampling approach. Technically, forceps- or portal and forceps- based interventions are applied despite creating a portal is time intensive and technically demanding [8]. For needle sampling, semi-automatic guillotine-type biopsy needles such as Quick Core biopsy frequently used [7]. So far, there has been no systematic study directly comparing different devices for hrMSUS-guided synovial biopsy.

Methods

Study set up

The study was performed with cadaver knee joints at the anatomic institute of the University of Basel, Switzerland. Synovial biopsy of the suprapatellar recess was performed by four senior rheumatologists. For ultrasound guidance we used a GE Logic S8XD Clear R3 machine with a ML6-15 probe and a frequency of 9-12 MHz. All interventions were recorded as static images and video clips.

Instruments

Four different synovial biopsy instruments were tested. 1. A core biopsy needle (Quickcore, 14G, Cook Medical, Bloomington, IN, USA), 2. A retrograde synovial biopsy needle (Retroforce, Karl-Storz GmbH, Tuttlingen, Germany) [5], 3. An anterograde forceps for arthroscopy (Karl-Storz GmbH, Tuttlingen, Germany) and 4. An integrated core needle system with a convexly shaped semi-blunt trochar (Synovex, Hipp Medical, Tuttlingen, Germany) [9].

Procedure

Prior to the intervention, 20 ml saline fluid was injected in the suprapatellar recess. The recess was sonographically visualized by a transverse view. After stab incision, the instruments were advanced through the capsule into the articular space until full ultrasound visibility. If necessary, transcutaneous pressure was applied to improve tissue yield. For each procedure, the rheumatologists rated from 0-5 (highest) the following issues: 1. visualization, 2. handiness, 3. accuracy, 4. synovial tissue yield, 5. invasiveness, and 6. overall suitability for ultrasound guided synovial biopsy. Mean scores were round up to whole numbers.

Results

All instruments were well visualized by hrMSUS (Figure 1). The closing mechanism was best seen in the core biopsy needle and the integrated needle system due to their horizontal shape. Both the anterograde and the retrograde forceps were visualized albeit the lower part of the anterograde forceps was seen less clear due to ultrasound reflection of the upper plier. The needle systems, notably the core biopsy needle were less invasive than the forceps but less handy e.g. due to tensioning and release of the spring. Accuracy and controllability were highest in the anterograde forceps as the tip can be directed to the target tissue by the distally located handle. The retrograde biopsy location of the retrograde forceps is determined by the site of capsule penetration. In contrast, the core needle has to be placed horizontally to the anterior wall of the joint capsule for full visibility and tissue yield. This horizontal contact guarantees a large yield of synovial layer, which is of notable interest in synovial biopsy. Horizontal pressure of the instrument against the capsule increased sonographic visualization of the core biopsy needle whilst this was not necessary with the integrated needle system due to its convex shape. Overall suitability for sonography-guided synovial biopsy was rated highest for the core biopsy system (Table 1).

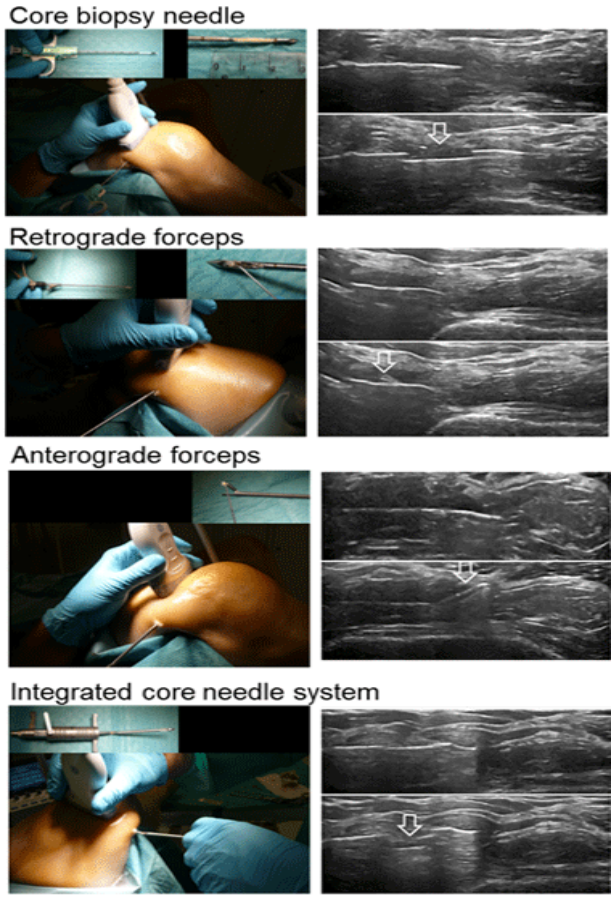

Figure 1: [Synovial biopsy using different devices 1. Core needle biopsy 2. retrograde forceps 3. Anterograde forceps and 4. Integrated core needle system. Pictures on the left shows high resolution musculoskeletal ultrasound (hrMSUS)-guided biopsy with the tissue yield in the upper picture. On the right, hrMSUS view with the instruments in closed (top) and opened (bottom) position (arrow).

Table 1:

	Fine needle	Retrograde foreceps	Anterograde forceps	Integrated needle
Visualization	5	3	4	5
Handiness	3	5	5	3
Accuracy	4	4	5	4
Synovial tissue yield	5	4	4	5
Miminal invasiveness	5	3	3	4
Overal suitability	**5**	**3**	**4**	**4**

Mean scores by four rheumatologists round up to whole numbers (0-5, 5 highest).

Discussion

This is the first study comparing different devices for their suitability in hrMSUS-guided synovial biopsy, a procedure of increasing interest. The results indicate that or the knee joint core needle biopsy is the most suitable procedure in this setting notably due to a low invasiveness, high superficial synovial layer tissue yield and good visualization. The results presented here are in line with the recommendations of the EULAR synovitis study group favoring needle-based approach for synovial biopsy over arthroscopy despite arthroscopy-guided techniques still are applied in current studies [10]. The integrated needle system demonstrated here seemed also suitable for hrMSUS-guided biopsy. The convexly shaped trochar improves horizontal contact to the synovial layer and unlike to the Quickcore instrument, synovial fluid aspiration can be performed. Clinical studies of this device are necessary. Both the anterograde and retrograde forceps were better controllable than the core needle due to the distally located handle and the procedure was performed more rapidly. On the other hand forceps are more invasive due to their mechanical construction. The retrograde forceps originally has been designed for a rapid synovial biopsy without concomitant imaging [5]. Aspiration of synovial fluid indicates intraarticular positioning and retraction of the open forceps is applied for contact to the capsule and synovial tissue, respectively. This instrument potentially is of higher value in orthopaedic situations such as prosthetic infection were targeting of specific lesions is not required [11].

Clearly, the results of this cadaver study have a strong technical aspect and the assessment might differ in the clinical setting taking into accounts variables such as pain, tolerability or capsule fibrosis. Fluid channels as in the retrograde forceps instrument or integrated needle system can be of additional value in the clinical setting e.g. allowing concomitant fluid aspiration or infiltration.

As a limitation of this technical study, we did not perform histological analysis of the obtained specimen. The yield of synovial tissue with those instruments has been demonstrated previously [5, 9].

Taken together, needle based instruments, notably core needle biopsy are suitable for hrMSUS -guided synovial biopsy. Larger clinical studies are necessary to assess notably the newer instruments for synovial biopsy.

Key Points

•Core needle sampling seems most suitable for hrMSUS-guided synovial biopsy due to low invasiveness, good visualization and tissue yield.

•Forceps-techniques are handy and accurate but more invasive than biopsy needles

Conflict of Interest

Dr. Hügle contributed to the development of the Retroforce and Synovex instruments and receives royalties from Karl-Storz GmbH and Hipp Medical AG.

Funding Statement

No funding was received for this study.

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