

# ACCELERATION MEASUREMENTS FROM PATIENTS WITH CPPD AND RHEUMATOID ARTHRITIS OF THE FINGER JOINT

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## ABSTRACT

Differential diagnosis of rheumatoid arthritis and calcium pyrophosphate deposition disease using noninvasive techniques is rather challenging. The purpose of the present investigation was to develop a noninvasive quantitative technique to differentiate between rheumatoid arthritis and calcium pyrophosphate deposition disease (CPPD) of the finger joint using fractal dimension calculated from the acceleration signals obtained from the finger joint of subjects suffering from arthritis. Fractal dimension of the subjects with rheumatoid arthritis was significantly different from the fractal dimension of the subject with calcium pyrophosphate deposition disease. The result of the study showed that fractal dimension along with other clinical symptoms can be used to distinguish between the two common types of arthritis of the finger joint.

## INTRODUCTION

Arthritis is a leading cause of disability in the United States. Arthritis leads to complex changes in the various cartilages and joints in the body. Often, it is difficult to differentiate between different types of arthritis like rheumatoid arthritis and calcium pyrophosphate deposition disease (CPPD) of the finger joint, due to common symptoms and involvement of common joints. Consequently, there is a need to develop noninvasive quantitative assessment technique to aid the differential diagnosis of these two types of arthritis. Reddy et al [1,2] have observed significant differences in the mean power of noninvasive acceleration measurements at the knee joint obtained from osteoarthritis, chondromalacia, rheumatoid arthritis and spondyloarthropathy patients. The question remains if noninvasive acceleration measurements obtained from the finger joint can be used to characterize CPPD and rheumatoid arthritis of the finger joint. The purpose of the present investigation was to address this question

## METHOD

Noninvasive acceleration measurements were obtained from the finger joint of rheumatoid arthritis patients and CPPD patients while the subject was performing repeated flexion-extension of the finger

(metacarpo-phalyngeal) joint. The rate of rotation was kept constant. The acceleration signals were filtered, amplified and acquired into a computer using an analog to digital converter.

Single cycles of flexion-extension were manually extracted by selecting the start and the end point of each cycle. Several parameters were extracted in time and frequency domains. In order to study the self-similarity in the signal, the fractal dimension was then calculated from these manually extracted single cycles. The fractal dimension was calculated using the procedure of Katz [3] and Gupta et al. [4]. T-test was then performed on the fractal dimension of the acceleration signals to show if the fractal dimension of the subject with Rheumatoid arthritis of the finger joint was significantly different from that of the subject with CPPD of the finger joint.

## RESULTS

Acceleration measurements were obtained from the finger joint of rheumatoid arthritis patients and CPPD patients and the measurements showed characteristic patterns. The fractal dimension calculated from CPPD subjects was  $1.7 \pm 0.1$ . For rheumatoid arthritis subjects the fractal dimension was found to be  $1.6 \pm 0.07$ . The T-test showed significant difference ( $p < 0.05$ ) between the fractal dimension of subjects with rheumatoid arthritis and CPPD of the finger joint.

## DISCUSSION

Clinically, differential diagnosis of rheumatoid arthritis and CPPD is often challenging. The results of the present investigation indicate that noninvasive acceleration measurements can be used for quantitative assessment of rheumatoid arthritis and CPPD of the finger joint. The study showed that the fractal dimension of the subjects with CPPD was higher than the subjects with Rheumatoid arthritis of the finger joint. CPPD is characterized by the presence of crystal in the synovial fluid and chondrocalcinosis of the cartilage [5]. This calcification associated with the cartilage make the joint surface rough and hence may lead to an increase in the vibrations developed during the motion of the joint.

The fractal dimension measures the complexity and spatial extent of the signal [3]. The increased vibrations in the acceleration signals, increases the spatial coverage of the signal and hence leads to an increase in the fractal dimension. In case of rheumatoid arthritis there is pannus formation at the joint and thickening of the synovial lining [6]. This pannus dampens the vibrations developed at the joint due to the motion of the joint and this may lead to the low measure of the fractal dimension in the subjects with rheumatoid arthritis.

Clinically, Rheumatoid arthritis can be diagnosed using blood tests and several other symptoms like joint swelling pain, stiffness, etc [7]. CPPD is diagnosed by aspiration of synovial fluid and examining it for the presence of calcium pyrophosphate crystals and also by viewing the X-ray of the patient for calcification of the cartilage [5]. It has been shown that aspiration of fluid is not a very sensitive and specific method of diagnosis [8]. Fractal dimensions provide a non-invasive method for differential diagnosis of different types of arthritis. Thus fractal dimension along with other clinical findings and symptoms can aid the clinician in decision making involving differential diagnosis.

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