

## Chapter 7

# Development of a Quantitative Method for the Detection of Periarticular Osteoporosis Using Density Features within ROIs from Computed Radiography Images of the Hand

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### **ABSTRACT**

*Periarticular osteoporosis of the hands and feet is one of the major diagnostic criteria for rheumatoid arthritis (RA). However, a quantitative method to detect periarticular osteoporosis using radiographs has not been reported. In this chapter, the authors propose a quantitative method for the detection of periarticular osteoporosis using density features of regions of interest (ROIs) from computed radiography (CR) images of the hand. The proposed method measures the density features of ROIs using histogram analysis, co-occurrence matrices, Fourier analysis, and the extraction of line components. Periarticular osteoporosis is detected using a discernment function based on these measurements.*

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*The sensitivity and specificity of the proposed method was assessed using 188 joints from 17 cases, including 6 normal cases (without periarticular osteoporosis) and 11 abnormal cases (with periarticular osteoporosis). The sensitivity of the method was 88.9%, and the specificity was 98.1%. Therefore, the authors consider this method to be potentially useful to radiologists for detecting periarticular osteoporosis in the hands.*

## **1. INTRODUCTION**

Osteoporosis is classified into primary osteoporosis and secondary osteoporosis (Greensp, 2000). Primary osteoporosis is mainly caused by aging or menopause. Secondary osteoporosis is caused by other diseases, such as rheumatoid arthritis (RA), hormonal disorders, and thyroid disease. Quantitative evaluation of primary osteoporosis has been well described (Caligiuri, et al., 1993; Guglielmi, Grimston, Fischer, & Pacifici, 1994; Ito, et al., 1995). However, quantitative evaluation of secondary osteoporosis has not yet been reported. In this paper, we describe a method for the quantitative evaluation of periarticular osteoporosis caused by RA.

RA is the most common type of inflammatory arthritis (Greensp, 2000) and often leads to the substantial disability and morbidity of patients as the disease progresses. Classically, RA has been thought to be irreversible once the destruction of bone has occurred. Fortunately, the advent of biological agents has helped prevent the progression of bone destruction caused by RA (Fan & Leong, 2007), making the early detection and treatment of this disease an important clinical issue.

The diagnosis of RA is primarily based on the classification criteria established by the American College of Rheumatology (ACR; Arnett, et al., 1988; Aletaha, et al., 2010). Radiography is the main diagnostic method used for the evaluation of bone damage, and it plays a major role in the diagnosis and the evaluation of therapy response (Boini & Guillemin, 2001). The diagnosis of RA using radiography has been performed using the Larsen (Larsen, Dale, & Eek, 1977) and

Sharp (Sharp et al., 1985) classifications, which subjectively assess the damage of the hand and foot bones. These methods result in scores based on some radiologic findings, including bone erosion, joint space narrowing, and periarticular osteoporosis.

However, these methods require a lot of observation time because all of the joints of the hand and foot must be evaluated by radiographs. In addition, it is sometimes difficult for a radiologist to assess the hand and foot radiographs in detail because the changes are small. Therefore, development of quantitative assessment of radiography is necessary. A few quantitative methods for the radiographic detection of bone erosion and joint space narrowing have been reported (Langs, Peloschek, Bischof, & Kainberger, 2009; Langs, Peloschek, & Bischof, 2003). However, these methods have not reached a practical level. In addition, quantitative methods for the detection of periarticular osteoporosis in hand or foot radiographs have not yet been published. In daily clinical practice, dual x-ray absorptiometry (DXA) and quantitative computed tomography (QCT) are used for the quantitative measurement of bone mass (Hall, et al., 1993; Njeh & Genant, 2000; Martin, Munro, Campbell, & Reid, 1997). These methods cannot accurately evaluate RA-induced periarticular osteoporosis of the hand and foot bones because DXA and QCT focus on the spine, hip, and wrist.

Here, we propose a quantitative method for the detection of periarticular osteoporosis from computed radiography (CR) images of the hand using the density features of regions of interest (ROIs).

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