ORIGINAL RESEARCH ARTICLE

Comparison of MDCT and Digital Radiography for the Characterization of Bone Healing

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A B S T R A C T

Introduction: Assessment of bone healing in orthopaedic patients is usually monitored by radiographs in two views. The purpose of our study was to compare multiplanar reconstructions from MDCT data sets with radiological findings for the assessment of the condition of bone healing process.

Material and methods: A total of 46 patients were included in this study for 1 and half year between the periods of January 2018 to July 2019. Patients with fractures, arthrodesis spinal fusion were included in this study. MX 8000 IDT with MDCT was performed as gold standard. The anatomical region was adapted for the technical parameters and for the bone reconstruction bone algorithm was used. 2 musculoskeletal radiologists were involved in analysis of radiographs and multiplanar reconstructions, also for the interpretation to determine bone healing.

Result: 65.12% of patients MDCT and digital radiological findings were showed similarity and 34.78% reported difference in two methods.

Conclusion: MDCT can be recommended as the primary diagnostic method for the estimation of bone healing.

Keywords: MDCT, Digital Radiography, Bone Healing, Musculoskeletal Imaging

INTRODUCTION

This study evaluates the value of MDCT compared with digital conventional radiography (using a flatpanel detector) in the diagnosis of bone healing or non-union in orthopaedic patients.[1] The role of MDCT to monitor bone progression, there was no clinical data available as per our knowledge.[1] Comparison of radiography, MDCT and histological findings in spine fusion model, MDCT proved to be better for the prediction of bone healing, therefore it's served as the gold standard method in this study.[2] Bone healing is the most important feature in patients with fracture, arthrodesis and osteotomies.[3] For the bone healing osteoprogenitor cells must be reached to the fracture site. Bone healing begins with endosteal and periosteal callus formation which leads to calcification and complete fusion of bone parts. In case if there is no complete fusion then it seems to be non-union.[4] Non-union may be due to loss of blood supply, mechanical instability or infection. Therefore it is mandatory for appropriate diagnosis an non-union's. The treatment of non-union such as, bone grafting, internal or external fixation, electrical or ultrasound stimulation or extracorporeal shock wave. The proper radiological image play important role in postoperative orthopaedic patients. Radiographs are used to monitor bone healing in patients. Bone production may start within 15 weeks and complete bone healing takes upto 3-6 months or longer.[5] There are some doubts on reliability of radiographs in monitoring fracture healing.[6] CT has been evaluated for the monitoring of fracture healing and it has been reported the advantages of CT over radiographs in early stage of fracture healing.[7] The isotropic or near-isotropic resolution is important to avoid the artifacts in CT and this problem has been solved by introduction of MDCT scanners.[8,9] Several studies reported advantages of MDCT to avoid artifacts.[10,11,12] The purpose of our study was to compare multiplanar reconstructions from MDCT data sets with radiological findings for the assessment of the condition of bone healing process.

MATERIAL AND METHODS

This was a retrospective study conducted in government medical college, Suryapet for the period of 1 and half year between the period of January 2018 to July 2019. A total of 46 patients included in this study who undergone MDCT and conventional radiography for the study of bone

production. Clinical histories of patients included fractures, spondylodesis, spondylodiskitis, arthrodesis, osteotomaies and shortness of long bones. The time recoreded between MDCT and radiography was 0-12 weeks. 16 MDCT scanner with standard scanning protocols were used to study the bone healing process (Table 1). Multix FD system (Siemens Medical Solutions) was used for digital radiography as per the standard clinical procedures. Statistical analysis software 20.0 used to analyze the data.

RESULTS

A total of 46 patients, MDCT reported 32.6% patients without prove of bone bridging, 53.5% showed evidence of partial fusion, and 14% showed complete fusion (Table 1). Overall agreement with digital radiography was found in 63% patients. Both the methods reported disagreement in 36.6% patients, bone production reported by digital radiography in 17.4% patients and underestimation in 17.4%. Detailed analysis showed that in CT group A (no fusion, 16 patients), agreement occurred in 9 patients (56.2%) and overestimation on digital radiography in 43.75%. Group B CT agreement occurred in 16 patients (64%), overestimation in 3 (1.2%), and underestimation in 6 (2.4%). In CT group C (complete fusion, 5 patients), agreement occurred in 3 patients (1.2%) and underestimation in 6 patients (2.4%). In CT group C (complete fusion, 5 patients), agreement occurred in 3 patients (60%) and underestimation in 2 (40%). Although Fisher's exact test indicated a significant correlation between CT and digital radiography (p= 0.007), the resulting kappa value was low (k= 0.348). MDCT was changed the diagnostic findings in 16 patients which previously given by digital radiography. Due to the less sample size, there was no significant difference found in 3 groups. The changes of diagnostic result ranged from 14% to 50%. MDCT changed the unreliable diagnostic confidence level to a better diagnostic confidence ratings at 37.5-50%. The digital radiography reported 24% diagnostic confidence as reliable and only 12% of diagnostic change by MDCT (Table 2).

Fusion on Digital Radiograph	Fusion on MDCT			
	None	Partial	Complete	Total
None	8	3	2	13
Partial	8	6	3	17
Complete	0	16	0	16
Total	16	25	5	46

Table-1: Results for Digital Radiography and MDCT for Bone Fusion in 46 patients.

Digital Radiograph	MDCT changed Digital Radiography		
	Yes	No	Total
Reliable	8	3	11
Fair	8	11	19
Unreliable	3	13	16
Total	19	27	46

Table-2: Percentage of Times MDCT Changed Initial Digital Radiography Diagnosis Based on the Diagnostic Reliability of Digital Radiography in 46 Patients.

DISCUSSION

This study shows that significant correlation exists between digital radiographs and MPRs from a 16-MDCT scanner in the evaluation of bone healing. The clinical importance of digital radiograph is questionable due to the low kappa value. Both method overall agreement was 63% with overestimation 19%and underestimation also 19% with regard to extent of bone fusion on digital radiography. In this present study MDCT was taken as gold standard. Several previous studies reported radiography and 4-MDCT has high sensitivity and negative predictive value, but the positive predictive value was poor. For the proper diagnosis of non-unions, MDCT proved to be superior than digital radiography reports.[2] Combination of the two methods can be performed well in interpretation of vascularised fibula autograft in patients with bone tumors. Indication unsuccessful vascularisation due to bridges absence to the allograft.[13] In 1986, CT was proved to be better diagnostic method over conventional radiography for the detection of gaps in callus.[14,15] The near isotropic imaging is prerequisite for better quality MPRs, which is also possible with non-helical CT scanners. However, helical CT is still limited by low scanning range. Introduction of modern MDCT scanners with high quality scanning range, and they are now widely used in clinical practice. There were are other imaging techniques used before the CT scanning are sonography and conventional tomography. The sonography method accuracy is up to 80% for the detection of pseudarthrosis after posterolateral spinal fusion.[16] Sonography reported better result over conventional radiography in visualization of new bone formation after fractures of long bones.[17] In case of paediatric radiology, sonography showed equal performance with conventional radiography, although sonography is best for detection of early sign of bone healing or pseudarthrosis.[18] However, penetration of the ultrasound beam is limited by the sonography technique, it is only limited to the cortical bones and superficial bones. Although conventional tomography used in musculoskeletal imaging, but it has been replaced by the CT method.[19] The tomography method used for long time for the evaluation of the postoperative spine after posterior spinal arthrodesis.[20] Although thin section tomography had correlation with surgery in the diagnosis of pseudarthrosis.[21] In dentistry radiology, orthopantomgraphy is still widely used. CT has increased the blurring problem of conventional tomography and increases the image quality of fracture healing. The most useful advantage of MDCT is use of X-ray beam passes through the whole volume of the object in less time. Another advantage of MDCT is reducing motion artifacts, because of the low scanning time comparison with conventional CT or tomography. The CT has the limitation due to metal implants which reduces the image quality. In this study 51.1% patients had metal devices, however detects only minor artifacts in most patients scanned. One of the limitation in this study was used slightly different protocols and different anatomic regions. However, this study reported digital conventional radiograph diagnostic confidence was unreliable in a high percentage of patients (Table 2). In significant number of patients data showed MDCT alter the

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diagnosis made by digital radiography (Table 1 and Table 2).

CONCLUSION

MDCT using high quality 2D reformatting, can be used as gold standard imaging techniques among others. This study reveals that radiography method can be unreliable diagnostic method and is not made the proper diagnosis for doubtful bone healing cases. Therefore, MDCT proved to be better diagnostic method as compared to digital radiography in patients with clinical suspicion of delayed union or non-union.

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