Quantitative assessment of glenohumeral cartilage using MRI T2 relaxometry for early degeneration detection: a prospective study.

Abstract:

Background: Early detection of cartilage degeneration is essential for preventing the progression of osteoarthritis. Conventional magnetic resonance imaging (MRI) has limitations in detecting subtle biochemical changes in cartilage. T2 relaxometry provides a quantitative approach for evaluating cartilage integrity.

Objective: To assess the utility of MRI T2 relaxometry in detecting early degenerative changes in the glenohumeral cartilage

Materials and ,methods : A prospective study was conducted on 18 patients below 50 years of age presenting with shoulder pain without trauma .MRI examinations were performed using 1.5 tesla scanners from two vendors with standardized imaging protocols .T2 maps were generated using vendor –specific software and analyzed using region of interest based measurements .

Results: The mean T2 relaxation value was 43.62+/- 10.35 ms with a range of 27.32 to 60.29ms. elevated T2 values were observed in 44.4% of patients .T2 mapping demonstrated improved sensitivity in detecting cartilage abnormalities compared to conventional MRI.

Conclusion: MRI T2 relaxometry is a reliable quantitative imaging technique for early detection of cartilage degeneration and provides additional diagnostic value beyond routine MRI.

Keywords:

MRI, T2 relaxometry, Glenohumeral joint, cartilage degeneration, quantitative imaging

Introduction:

Cartilage degeneration plays a signification role in the development of osteoarthritis, particularly in highly mobile joints such as the glenohumeral joint (1).early identification of degenerative changes is essential for preventing disease progression and preserving joint function (2).however, conventional magnetic resonance imaging (MRI) primarily evaluates structural abnormalities and may not detect early biochemical change sin cartilage.(3)

Quantitative MRI techniques have emerged as valuable tools for assessing cartilage composition(4–6). T2 relaxometry reflects collagen matrix integrity and water content within cartilage ((7,8). Increased T2 relaxation times are associated with disruption of collagen architecture and increased hydration, which are early indicators of degeneration. ((9,10)

Although extensively studied in weight-bearing joints such as the knee , the application of T2 relaxometry in shoulder cartilage remains limited (11,12). Given the clinical importance of early diagnosis, this study aims to evaluate the role of T2 relaxometry in detecting early degenerative changes in glenohumeral cartilage.

Materials and methods

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Study design and setting

A prospective study was conducted over a period of three months (January 2020 to March 2020) in the department of radiology and imaging sciences at Sri Ramachandra institute of higher education and research, Chennai, India.

Study population: a total of 18 patients below the age of 50 years presenting with shoulder pain without a history of trauma were included

Inclusion criteria

Patients aged <50 years

Shoulder pain without trauma

Exclusion criteria

History of shoulder surgery, traumatic injury, known shoulder pathology

MRI acquisition protocol

MRI examinations were performed using 1.5 tesla scanners from two vendors (Siemens magneto avanto and GE signa series) with dedicated shoulder coils.

Routine imaging included T1 –weighted, T2 –weighted and proton density fat –saturated sequences.

T2 relaxometry was performed using a multi-echo-spin-echo sequence with comparable parameters across both systems. imaging parameters were standardized to ensure consistency of quantitative measurements (table 3)

Table 3. MRI acquisition parameters across different vendors

PARAMETER	Siemens (Magnetom avanto)	GE (signa series)
Field strength	**1.5 tesla**	**1.5tesla**
Scan plane	*Oblique coronal*	*Oblique coronal*
Mode	*2D*	*2D*
Pulse sequence family	*Spin echo*	*Spin echo*
Pulse sequence	*FSE-T2*	*FSE-T2*
TR (ms)	*1020*	*1020*
TE (ms)	▪ *13.9* ▪ *27.8* ▪ *41.7* ▪ *55.6* ▪ *69.5*	▪ *13.9* ▪ *27.8* ▪ *41.7* ▪ *55.6* ▪ *69.5*
FOV read (mm)	*160*	*160*
FOV phase (%)	*100*	*100*

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Slice thickness (mm)	*3-4mm*	*3-4mm*
Spacing (mm)	*1*	*1*
Flip angle (degree)	*180*	*180*
Matrix/phase resolution	*224 x 320*	*224 x 320*
NEX	*1*	*1*
Scan time	*3:20 min*	*3:20 min*

Post processing and T2 analysis

T2 maps were generated using vendor–specific platforms (syngo MR workplace for Siemens and GE AW workstation for GE systems). Despite differences in workflow, both systems employed mono-exponential fitting models.

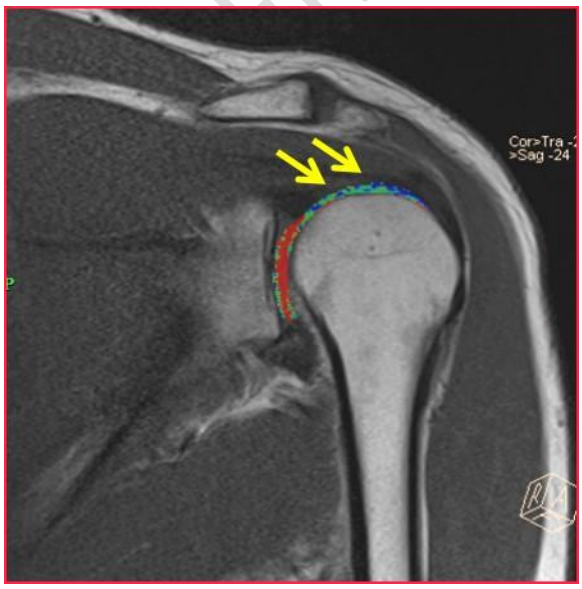
Regions of interest (ROI) were manually placed over the glenohumeral cartilage with care to avoid partial volume effects. Consistency in ROI placement was maintained across all cases.

Statistical analysis:

Descriptive statistics were used. Mean, standard deviation, and range were calculated. The proportion of patients with elevated T2 values was determined.

Results

A total of 18 patients were included in the analysis .The mean T2 relaxation value was 43.62 +/- 10.35ms with a range of 27.32 to 60.29ms (table-1).Among the study population ,8 patients (44.4%) demonstrated elevated T2 values .10 patients (55.6%) had normal values (table 2).T2 relaxometry enabled detection of early cartilage abnormalities through increased relaxation values improved visualization using color-coded maps (fig.1).In several cases, conventional MRI sequences did not demonstrate abnormalities, whereas T2 mapping revealed elevated values (fig.2).The distribution of T2 relaxation values is illustrated in (fig.3)



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Figure.1. T2 relaxometry color map showing increased T2 values in glenohumeral cartilage indicating early degeneration

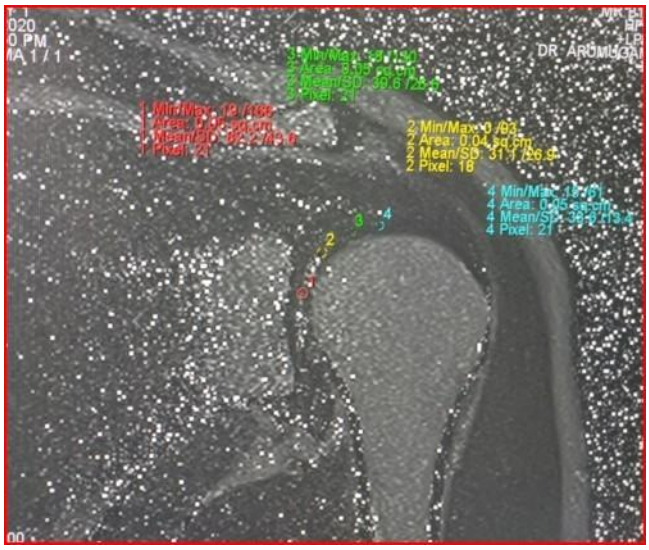


Figure.2. conventional MRI image with corresponding T2 map demonstrating elevated relaxation values not appreciable on routine sequences

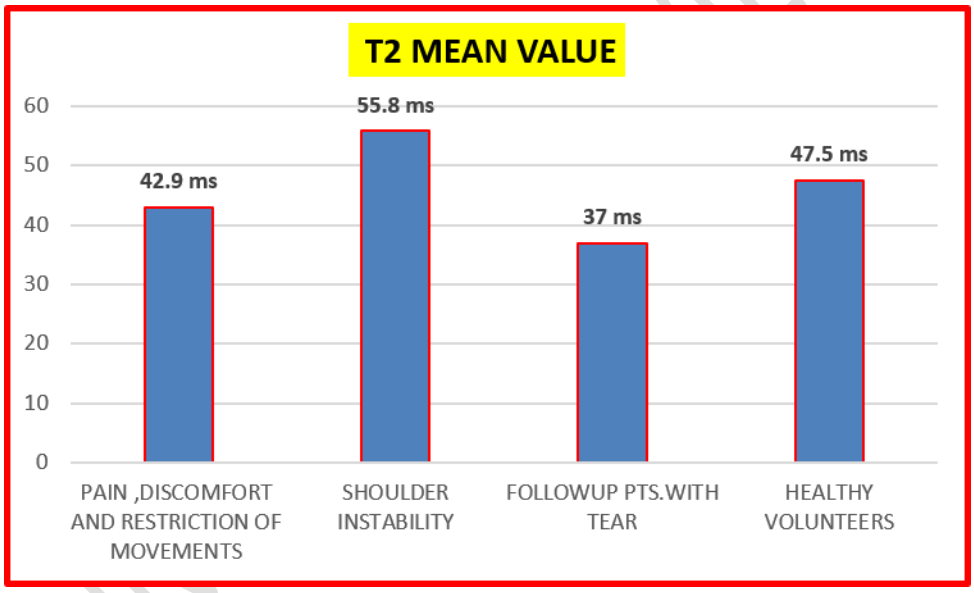


Figure.3.Graph showing distribution of T2 relaxation values among study population

Table1.summary of T2 Relaxometry values

Parameter	Value
Sample size	**18**
Mean t2 value	**43.62ms**
Standard deviation	**+/-10.35ms**

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Range	**27.32 - 60.29ms**

Table 2. Distribution of patients based on T2 values

Category	Number of patients	Percentage
Elevated T2 values	**8**	**44.4%**
Normal T2 values	**10**	**55.6%**

Discussion:

This study demonstrates the utility of MRI T2 relaxometry in detecting early degenerative changes in glenohumeral cartilage. Conventional MRI is primarily limited to morphological evaluation and may not identify early biochemical alterations

The mean T2 value observed in this study (43.62+/- 10.35 ms) and the proportion of patients with elevated values (44.4%) indicate the presence of early cartilage degeneration. increased t2 values reflect disruption of collagen architecture and increased water content.

T2 mapping showed improved sensitivity compared to routine MRI, particularly in cases where conventional imaging appeared normal. This highlights its importance as a complementary diagnostic tool

The use of scanners from different vendors and variation of sin post-processing platforms may introduce minor variability in measurements. However, standardized acquisition parameters and consistent ROI-based analysis were employed to minimize this effect.

Limitations include small sample size and lack of longitudinal follow-up. Future studies with larger populations are required to establish standardized reference values.

Conclusion

MRI T2 relaxometry is a reliable and non-invasive technique for detecting early degenerative changes in glenohumeral cartilage. It enhances diagnostic sensitivity compared to conventional MRI and has potential clinical value in early disease detection.

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