

**DETECTION OF KNEE CHONDRAL DEFECT BY  
3-DIMENSIONAL WATER SELECTIVE FOR  
CARTILAGE SEQUENCE (3D WATSc) IN 3.0 T  
MAGNETIC RESONANCE IMAGING**

**DR FATTAH RAHIMAN BIN GHAZALI**

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## LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS

3D WATSc	3-dimensional water selective for cartilage
MRI	Magnetic resonance imaging
ECM	Extracellular matrix
OARSI	OsteoArthritis Research Society International
OA	Osteoarthritis
RF	Radiofrequency
FSE or TSE	Fast or turbo spin-echo
SNR	Signal-to-noise ratio
CNR	Contrast-to-noise ratio
PD	Proton density
T1-FFE	T1-fast field echo
FLASH	Fast low angle shot
SPGR	T1-weighted spoiled gradient recalled
FFE	Fast field echo
GRE	Gradient recalled
GRASS	T2*-weighted gradient recalled echo acquired in the steady state
DESS	Dual echo in the steady state
IR	Inversion recovery
PROSET	Principle of selective excitation technique
SSFP	Steady-state free precession

# **PENGESANAN KECEDERAAN TULANG RAWAN LUTUT OLEH JUJUKAN 3-DIMENSI SELEKTIF AIR UNTUK TULANG RAWAN (3D WATSc) DALAM PENGIMEJAN RESONANS MAGNETIK 3.0 T**

## **ABSTRAK**

**Pengenalan:** Kecederaan tulang rawan lutut merupakan salah satu punca kesakitan dan ketidakupayaan. Artroskopi merupakan kaedah penanda aras untuk mengesan kecederaan tulang rawan lutut tetapi invasif. Pengimejan resonans magnetik merupakan kaedah tidak invasif yang sering digunakan untuk pengesanan kecederaan tulang rawan lutut. Banyak jujukan pengimejan resonans magnetik telah dikembangkan untuk menilai tulang rawan namun keputusan yang diperolehi adalah tidak konsisten dengan batasan yang tertentu. Sehingga kini tiada satu kata sepakat dalam jujukan pengimejan resonans magnetik untuk penilaian tulang rawan. Tujuan kajian ini ialah untuk menilai pengesanan dan pengredan kecederaan tulang rawan dalam pengimejan resonans magnetik 3.0 T menggunakan jujukan 3-dimensi selektif air untuk tulang rawan (3D WATSc), dan perbandingan dibuat dengan jujukan ketumpatan proton (PD) dan artroskopi sebagai piawaian.

**Kaedah:** Kajian retrospektif ini telah dijalankan di Hospital Universiti Sains Malaysia (HUSM), Kelantan, dari Januari 2017 hingga Jun 2020. Imej MRI dengan jujukan-jujukan PD dan 3D WATSc bagi pesakit-pesakit yang memenuhi kriteria penyertaan telah dikaji oleh dua penilai bebas. Kewujudan kecederaan tulang rawan lutut dan pengredannya dalam kedua-dua jujukan tersebut direkod dan dibandingkan dengan penemuan artroskopi. Korelasi antara kelas (ICC) untuk pengredan kecederaan tulang rawan lutut antara kedua-dua penilai dilakukan untuk menentukan kebolehpercayaan antara penilai, dan didapati terdapat kebolehpercayaan antara penilai yang baik untuk



penilaian kecederaan tulang rawan lutut dalam PD dan 3D WATSc. Ujian berperingkat Wilcoxon digunakan untuk menguji perbezaan dalam gred antara PD dan 3D WATSc. Kepekaan, kekhususan dan ketepatan telah dikira untuk penggredan PD dan 3D WATSc menggunakan penggredan artroskopi sebagai piawaian.

**Keputusan:** Sebanyak 70 subjek (53 lelaki; 17 perempuan) dengan purata umur 29.59 tahun (15-44) telah dimasukkan dalam kajian rentas ini. Kelaziman kecederaan tulang rawan lutut yang dikesan oleh PD, 3D WATSc dan artroskopi masing-masing ialah 55.7 %, 48.6 % dan 44.3 %. Majoriti subjek dinilai sebagai Gred 0 di dalam semua kaedah penilaian dengan sebahagian besar subjek dinilai sebagai Gred II, Gred III dan Gred IV. Tiada perbezaan yang signifikan secara statistik dalam penggredan kecederaan tulang rawan lutut antara PD dan 3D WATSc ( $p>0.05$ ). Kepekaan, kekhususan dan ketepatan 3D WATSc masing-masing ialah 77%, 74% dan 76%, dan PD masing-masing ialah 64%, 81% dan 71%.

**Kesimpulan:** Kajian ini menunjukkan bahawa prestasi diagnostik 3D WATSc tidak lebih unggul daripada PD dalam pengesanan kehadiran dan penilaian kecederaan tulang rawan lutut oleh 3.0 T MRI. Jujukan ini juga hanya mempunyai kepekaan, kekhususan dan ketepatan yang sederhana dibandingkan dengan artroskopi sebagai piawaian. Oleh itu, 3D WATSc tidak dapat mengatasi jujukan PD dalam menilai kecederaan tulang rawan lutut. Kajian prospektif diperlukan untuk menilai lebih jauh ketepatan diagnostik 3D WATSc dalam MRI 3.0 T.

**Kata kunci:** Kecederaan tulang rawan, 3-dimensi selektif air untuk tulang rawan (3D WATSc), ketumpatan proton (PD), pengimejan resonans magnetik, artroskopi.

# **DETECTION OF KNEE CHONDRAL DEFECT BY 3-DIMENSIONAL WATER SELECTIVE FOR CARTILAGE SEQUENCE (3D WATSc) IN 3.0 T MAGNETIC RESONANCE IMAGING**

## **ABSTRACT**

**Introduction:** Knee chondral defect is one of the important causes of pain and disability. Arthroscopy is the gold standard method in detecting knee chondral defects however it is invasive. Magnetic resonance imaging (MRI) had been used as a non-invasive method in detecting knee chondral defect. Many MRI sequences had been developed for assessing the cartilage however it still pose limitations and inconsistent results. To date there is no general consensus for the MRI sequence in cartilage assessment. This study aims to assess the detection and grading of knee chondral defect in 3.0 T MRI using 3-dimensional water selective for cartilage (3D WATSc) sequence, in comparison with proton density (PD) sequence and gold standard arthroscopy.

**Methodology:** This retrospective study was conducted in Hospital Universiti Sains Malaysia (HUSM), Kelantan, from January 2017 until June 2020. MRI images of PD and 3D WATSc sequences of patients who fulfilled the inclusion criteria were independently reviewed by two independent raters. Presence of chondral defect and the grading in these two sequences were recorded and compared with arthroscopy findings. The interclass correlation coefficient (ICC) using absolute agreement under two-way mixed model for the grading between two raters was performed to determine the inter-observer reliability, which showed good inter-observer reliability for the grading of knee chondral defect in PD and 3D WATSc. Wilcoxon signed ranks test was used to test the differences in grade

between PD and 3D WATSc. Sensitivity, specificity and accuracy were calculated for PD and 3D WATSc grades using the arthroscopy grades as standard reference.

**Results:** Total of seventy subjects (n=70), predominantly male (53 males; 17 females) with a mean age of 29.59 years old (15-44) were included in this cross-sectional study. The prevalence of knee chondral defect detected by PD, 3D WATSc and arthroscopy were 55.7 %, 48.6 % and 44.3 %, respectively. Majority of subjects were rated as Grade 0 across all assessment modalities with significant portion of subjects were rated as Grade II, Grade III and Grade IV. No statistically significant in the difference of knee chondral defect gradings between PD and 3D WATSc ( $p>0.05$ ). The sensitivity, specificity and accuracy of 3D WATSc were 77 %, 74 % and 76 %, and PD were 64 %, 81 % and 71 %, respectively.

**Conclusions:** The study showed that the diagnostic performance of 3D WATSc is not superior to PD in the detection of presence and grading of the knee chondral defect by 3.0 T MRI. The sequence also only had moderate sensitivity, specificity and accuracy as compared to gold standard arthroscopy. Therefore it cannot outperform PD sequence in assessing the knee chondral defect. Future prospective study is needed to further evaluate the diagnostic accuracy of 3D WATSc in 3.0 T MRI.

**Keywords:** Knee chondral defect, 3-dimensional water selective for cartilage (3D WATSc), proton density (PD), magnetic resonance imaging (MRI), arthroscopy.