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ANSWERING REVIEWERS

Name of journal: World Journal of Orthopedics
ESPS manuscript NO: 24186
Title: 3D Reconstructed magnetic resonance scans: Accuracy in identifying and defining knee meniscal tears

Reviewer's code: 02691156
Comments to authors: The purpose of this study was to determine whether 3D reconstruction from conventional MRI is able to accurately detect a meniscal tear, and define the configuration. The structure of the manuscript is according to the guidelines of WJO. The title is referring directly to the problem at hand and the abstract is rather comprehensive. The Introduction of the study is short and the authors emphasize that the importance of the knee menisci are vital to tibiofemoral contact mechanics and joint longevity. Although MRI is commonly used to diagnose a meniscal tear, this however relies heavily on specialist radiological interpretation for diagnosis. With current advancement in 3D reconstruction technology, this study aimed to determine whether 3D reconstruction of meniscal tears using current MRI protocols could accurately identify meniscal tears, and define their configuration. Materials and methods The authors use the following subtitles: Sample population, MRI features, 3D reconstruction and 3D image analysis. The population consisted of 24 meniscal tears in 24 patients, and nine control menisci. In all cases arthroscopy was performed after preoperative MRI had indicated a potential meniscal tear. All patient MRI data for the 3T scans were imported into the Materialize Interactive Medical Control System (MIMICS) 3D reconstruction software program. Two surgeons, both familiar with the different types of meniscal tears, reported on the reconstructions. Results The accuracy for both observers and for bucket handle tears was 80%. However it had a lower accuracy in determining the remaining menisci tear configurations. It seems, that it is not possible, for the moment, to accurately determine menisci tear extension to the periphery, and consequently neither to predict the healing process between red and white zone. Discussion The authors state that MR diagnosis of a meniscal tear relies both on signal contrast and morphology. In identifying meniscal tear presence or absence, the accuracies, sensitivities and specificities, as well as positive and negative predicative values in this study were equal to those obtained from MRI. Investigating by mensical tear configuration, 3D reconstruction appeared useful in identifying normal menisci. However it had a lower accuracy in determining the remaining meniscal tear configurations. Minimising these inaccuracies will increase the MRI quality, and hence the meniscal tear definition in 3D reconstruction. Adopting an isotropic volume scan protocol for clinical knee MRI scanning eliminates the interslice gaps, as the whole volume is scanned simultaneously. Conclusion Uni-planar 3D meniscal tear reconstruction is useful in identifying normal menisci and menisci with bucket handle tears. It however is unable to accurately report the

remaining meniscal tear configurations. References are including 26 published papers. Finally, there is no doubt that, with the submitted manuscript, the authors present an innovative technique, in order to improve 3D Reconstructed magnetic resonance scans. This tri-planar reconstruction is anticipated to have finer meniscal tear and border definition, increasing the accuracy in differentiating between the morphologically similar tears. Although the proposed 3D MRI reconstruction reached an 80% of diagnostic accuracy for bucket handle meniscal tears and a lower accuracy for the remaining tears, on the other hand, arthroscopy is the therapeutic modality that complete, both the diagnostic accuracy and the desired treatment. Nevertheless, the proposed diagnostic method helps and adds definitively high quality diagnostic accuracy to take the right decision. The submitted manuscript in the present form, possess both scientific and practical value and should be accepted for publication.

Answer: Thank you very much for the extended comments and positive feedback from your review. I have had to make some minor adjustments to address the other reviewers' comments, but have not lost the salient message conveyed in the research in making these amendments. Once again, thanks very much for taking the time in your appraisal.

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Reviewer's code: 02699758

Comments to authors: The authors demonstrated the accuracy for meniscal tears on 3D reconstructed MRI. Although diagnostic accuracy of meniscal tear presence was high, accuracy of the tear type was extremely low. They stressed the importance of advance of MRI quality in the discussion. So far, there have been very few papers that demonstrated the clinical use for the 3D reconstructed images of menisci in the literature. Therefore, I recommend this paper to be published. But, the problem is the very low accuracy for detecting the tear types on 3D reconstructed images, unfortunately. The authors should compare the accuracy for detecting the tear type between 3D reconstructed images and conventional 2D MR images as the arthroscopic findings are gold standard. And once again, they should demonstrate the advantages of 3D MRI over conventional 2D MR images and also the limitation of the 3D reconstructed images. If the authors can resolve the above assignment, I would be in favor of the publication of their report.

Answer: Thank you for your constructive comments in improving the quality of the paper. I have taken them all on board and rewritten and amended the various sections to elaborate on and answer the questions you posed. Please find the highlighted references in red in the main body of the manuscript as to where to find them.

As suggested I've introduced a table (included below for reference) comparing the 3D reconstruction to the 2D MRI images regarding meniscal tear configuration. It has been incorporated in the results section. The second part in demonstrating the advantages of 3D MRI over conventional 2D MRI, and the limitations of the 3D reconstructed images are addressed in the discussion, again highlighted in red.

Table 5 The sensitivities for meniscal tear type detection for previous studies utilizing 2D MRI as compared to our results using the 3D reconstruction of meniscal tears.

	Radial (%)	Bucket-handle (%)	Oblique (%)	Horizontal cleavage (%)	Complex (%)
Jee et al (27)	8 of 11 (72.7)	-*	3 of 5 (60.0)	35 of 44 (79.5)	18 of 22 (81.8)
Jung et al (28)	26 of 36 (72.2)	-*	2 of 2 (100.0)	28 of 32 (87.5)	1 of 2 (50.0)
Wright et al (29)	-*	25 of 39 (64.1)	-*	-*	-*
Kruger et al	1 of 6 (16.7)	4 of 5 (80.0)	2 of 5 (40.0)	3 of 5 (60.0)	1 of 3 (33.3)

*** No such tear configuration specified in the study**

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Reviewer's code: 02699853

Comments to authors: This study is a good reference to achieve a necessary improvement in the field of diagnosis of meniscal lesions, but I have some concerns to be taken into account: 1. First paragraph of introduction is not relevant. Delete it. 2. Start Material and Methods by specifying the study design. 3. Why did you not include longitudinal non-displaced tears in your analysis? 4. Have you made some differentiation between traumatic and degenerative tears? What was the training by the Materialise staff in using the software? How long it took? How was the risk of bias of these reconstructions? 5. How was the 3D meniscal model produced? 6. What was the training of observers? Who teach that training? How long it took? Was the learning curve similar for the two observers? 7. Please, report the mean and range of elapsed time between MRI and the arthroscopy. 8. The degree of agreement of observers is low limiting the value of results. 9. Exhibiting equal accuracy, sensitivity and specificity, as well as positive and negative predictive values in identifying meniscal tear presence or absence, it seems of little relevance the advantage of 3E MRI over conventional MRI. 10. How is the difference in cost between the two techniques? 11. You claim that all those parameters are not dependent on the radiologic skill or experience for interpretation, but the observers needed training to become familiar with meniscal appearances in 3D, being poor the degree of intra- and inter-observer agreement in this interpretation. 12. Please, discuss limitations of the study, taking into account sources of potential bias or imprecision.

Answer: Thank you for your constructive comments in improving the quality of the paper. I have taken them all on board and rewritten and amended the various sections to elaborate on and answer the questions you posed. Please find the highlighted references below in yellow for some explanation and as to where to find them in the edited manuscript. (Please also note that one or two of the points you raised were similar to one other reviewer and the edits thereof are highlighted in red in the body of the manuscript).

1. First paragraph of introduction is not relevant. Delete it. I feel this paragraph adds value to the introduction in emphasizing the importance of the knee meniscus and the significance of tears thereof. On review it was rather disjointed with respect to the flow of the second and third paragraphs and I've amended it according. Hopefully you agree that it flows better as I would like to keep it.
2. Start Material and Methods by specifying the study design. See Methods
3. Why did you not include longitudinal non-displaced tears in your analysis? See Discussion
4. Have you made some differentiation between traumatic and degenerative tears? No differentiation between traumatic and degenerative tears, this is now discussed in the discussion and thanks for highlighting it. What was the training by the Materialise staff in using the software? I am not certain of this. They are obviously company employees who

have been trained in the use of software up to the point of enabling them to then teach others how to use it. How long it took? See Methods. How was the risk of bias of these reconstructions? See Methods

5. How was the 3D meniscal model produced? See Methods
6. What was the training of observers? See Methods Who teach that training? The lead author – the details of this now specified in the methods How long it took? See Methods. Was the learning curve similar for the two observers? See Methods
7. Please, report the mean and range of elapsed time between MRI and the arthroscopy. See Results and elaborated on in the discussion now
8. The degree of agreement of observers is low limiting the value of results. The degree of agreement is moderate, and ideally would be either substantial or near perfect, however these are the results that were obtained and I feel there is still credibility in the findings.
9. Exhibiting equal accuracy, sensitivity and specificity, as well as positive and negative predictive values in identifying meniscal tear presence or absence, it seems of little relevance the advantage of 3E MRI over conventional MRI. The relevance of the findings is now further elaborated on in the discussion, as well as the shortcomings elaborated on in the discussion as requested.
10. How is the difference in cost between the two techniques? The cost of the MIMICS software program is once off and thereafter there are no/low costs involved. I emailed the supplier and their response was between 3000 and 5000 pounds for the licence, software, installation and upkeep. The number of reconstructions are then effectively only limited by the speed of the person doing the reconstructions (which will improve with better technology, more function automation etc) Increasing the number of reconstructions per annum or month would then decrease the total cost per patient that needs to be recouped, until it would be almost negligible. Conservatively doing 10 MRI's per day and assuming a 5 day work week, multiplied by 4 weeks per month for each month of the year then: 10 x 5 x 4 x 12 = 2400, which loosely equates to an extra 1.50 pounds per person.
11. You claim that all those parameters are not dependent on the radiologic skill or experience for interpretation, but the observers needed training to become familiar with meniscal appearances in 3D, being poor the degree of intra- and inter-observer agreement in this interpretation. See Methods… and comparatively the degree of explanation required to familiarize the viewer (an orthopaedic trainee) (or a viewer with comparatively even less medical or anatomical knowledge) with what a meniscal tear looks like in a completed 3D reconstruction versus the skill required to accurately diagnose a meniscal tear on the MRI

(effectively requiring radiologist training) is great. The trainees were chosen both for their availability and lack of understanding of what a meniscal tear would look like in 3D, as neither of them had been exposed to this prior.

12. Please, discuss limitations of the study, taking into account sources of potential bias or imprecision. See Discussion.