Author’s response to reviews

Title: Computer Aided Vertebral Visualization and Analysis: A Methodology Using the Sand Rat, a Small Animal Model of Disc Degeneration

Authors:

Christy Wilson (chrwilso@uncc.edu)
Darien Brown (dobrown@uncc.edu)
Kayvan Najarian (knajaria@uncc.edu)
Edward N Hanley Jr (Edward.hanley@carolinashealthcare.org)
Helen E Gruber (Helen.gruber@carolinashealthcare.org)

Version: 6 Date: 17 Mar 2003

PDF covering letter
Response to Reviewers for the manuscript “Computer aided vertebral visualization and analysis…:

Response to Dr. Remes:

We thank Dr. Remes for the helpful comments. We have incorporated the suggestions wherever possible and feel that they have lead to an improved manuscript. Specific responses are detailed below:

1) With respect to the number of radiographs analyzed (also questioned in point #8 in the review), as stated in the title, this paper is intended as a pilot study to present a method of computer aided vertebral visualization and analysis. Some data are presented to illustrate the potential of the methods. We have now emphasized this point in the final paragraph of the Background section.

2) There is a Methods section which follows the Background (perhaps the reviewer here meant to note that in the Abstract, the Methods section was out of place; this has been corrected).

3) Yes, the text does have mathematical elements; however, since the paper presents a new application of computer methods, we feel that this is very essential. However, if the reviewer still has issues with this, we suggest that the Editor be consulted to decide the issue and we will be happy to abide by that decision.

4) The issue of repeatability is discussed below.

5) We have added a new paragraph and new references to the Discussion which explain the biological importance of end plate sclerosis in disc degeneration.

Abstract: Background:

1) As suggested, comments have been added about the value of the proposed methods. A similar sentence has been added to the end of the last paragraph of the Background.

2) The text now reads that selected representative radiographs have been used in this study.

3) The text now reads “may be applicable to human and other animal radiologic models of the aging/degenerating spine”.

Background:

4) As suggested, the first sentence now reads “In the past, animal models in the study of disc degeneration have most commonly involved…”
5) As noted above, a comment on possible benefits of this method has now been added to the end of the Background section.

6) As noted above, a section has now been added to more fully help the reader understand the importance of end plate sclerosis. This is now in the Discussion section. The reviewer is indeed correct in that end plate sclerosis is only one element which is important in consideration of disc degeneration. A parenthetical comment has now been added which reads “(which may be a major factor in reducing the nutrition available to the aging disc)”.

**Materials and Methods:**

7) The reviewer is correct and a new paragraph has been added at the beginning of the Methods section to insert this information.

8) As noted above, the present small paper is intended as a pilot study to present a method of computer aided vertebral visualization and analysis, not as a presentation of data from all radiographs of the previous work.

9) In the laboratory of Dr. Gruber, we have a backlit digitizing tablet which we have in the past used for hand measurements; however, we feel that the methods presented here were of a different scope and therefore did not have that as a part of the present study.

10) We request that we defer to the Editor re the retention of Figure 1. For the casual reader, we suggest that it is a useful orientation guide and we request that it be retained.

11) We request that we defer to the Editor to decide whether the “mathematical” components be retained. We would prefer to have this information as an integral part of the paper since its focus is on the newly presented methods.

12) We are sorry that we are not able to understand what this specific comment refers to in the text.

13) There are no threshold values used because this method only makes quantitative measurements, it does not perform any interpretation of the data. For threshold values to be determined and used the method will need to be applied to a larger data set, and the measurements be interpreted by a person to find the appropriate range for threshold values.

14) Again, we have difficulty understanding what the reviewer means here by “the depth of the vertebrae”…is this mean width?
15) An additional table has been added (Table 3) which contains the overall angle of the curvature of the spine information.

16) The reviewer has brought up here the interesting points of applicability in clinical conditions of kyphosis, scoliosis, lordosis etc. However, we feel that these issues go beyond the scope of the present small study. The revised text in the Discussion now reads “The proposed method can be applied to further our methods of analysis in animal models of important features of spine aging such as sclerosis of the vertebral end plates.”

17) The entire process for a typical vertebral image takes less than 15 minutes on a 1.3 GHz PC using MATLAB. The time needed for manual analysis depends highly on the individual investigator and cannot be directly compared with the computerized method shown here. In addition, many automated measurements and analyses performed by the algorithm cannot be manually performed.

Results:

18) As noted above, since this is a technical methods paper, we request that this table be retained, but will defer to the decision of the Editor.

19) The ‘Orientation Slope’ column has been removed from Table 2 and the ‘Sclerosis Index L’ and ‘Sclerosis Index R’ columns have been changed to ‘Sclerosis Upper Index’ and ‘Sclerosis Lower Index’, respectively.

20) Unlike human investigators (who might miss some information or points in one observation but notice the same information on another observation), our technique is entirely repeatable and different runs using the same image result in the same exact results. In other words, the algorithm performs a routine analysis regardless of the run and the image. Running the algorithm on different images with similar information also results to similar results.

Discussion:

21-1) MRI will allow soft tissue components to be studied. The present method is focused upon computer characterization of the bony elements visible in x-rays. We have not added a discussion of this to the text.

21-2) Pros:
   - Unlike humans, the computer algorithm can make exact quantitative measurements on all important parameters (e.g. sclerosis of the end plate)
   - Computer analysis is less subjective (as opposed to manual results that depend highly on the human user/expert)
In general, the automated analysis can be faster than manual measurements.

Processing low-quality images might be difficult for humans while image processing techniques automatically enhance the image quality before processing the information.

**Cons:**

- Images need to be scanned to create digital data (extra cost and complexity)
- Humans might use certain heuristics in their analysis that cannot be directly translated into mathematical methods

21-3) This has been discussed above.

21-4) The only source of error might be the misinterpretation of the results by the human user. As to other limitations, please read “Cons” in 21-2.

21-5) Hough Transform (used in our technique) can discover any direction along any line in the 2-D plane and therefore considers that in subsequent processing steps.

21-6) As noted above, at present our methods are focused on animal models and any detailed clinical applications at present would be very premature.

---

**Response to Dr. McGregor:**

We thank Dr. McGregor for the helpful comments. We have incorporated the suggestions wherever possible and feel that they have lead to an improved manuscript. Specific responses are detailed below:

1) The error in order has been corrected. Thank you for catching this for us (as did Dr. Remes)

2) We feel that the statement at the end of the first paragraph of the Background presents a good statement of our purpose: “The present work extends the previous radiological studies in [1] to develop an automated computer-assisted procedure that analyses digitized lateral x-rays of the sand rat spine. “

3) We feel that this method is a useful experimental adjunct to the present radiologic semi-quantitative methods that are routinely used in the lab. This reviewer is entirely correct in that validity, reproducibility and accuracy are important components. We have addressed some of these issues as requested by Dr. Remes.

4) We are requesting the editor to retain Figure 1 since it provides a good visual guide. Perhaps during final editing your point about the bullets will be corrected.
5) Giving too much detailed mathematical description of the technique is something that Dr. Remes has also noted. I believe that every piece of the algorithm is more or less standard technique, known and used by the biomedical engineering and signal processing community for decades and we don’t believe defining, for example Canny Edge Detectors, in more detail would be appreciated by many readers. If there is any particular sub-method that is needs to be further explained, we can certainly elaborate on that.