Reviewer Assessment

Verónica García-Vázquez*, Felix von Haxthausen, Sonja Jäckle, Christian Schumann, Ivo Kuhlemann, Juljan Bouchagiar, Anna-Catharina Höfer, Florian Matysiak, Gereon Hüttmann, Jan Peter Goltz, Markus Kleemann, Floris Ernst and Marco Horn

Navigation and visualisation with HoloLens in endovascular aortic repair

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Reviewers' Comments to Original Submission

Reviewer 1: anonymous

Jul 04, 2018

Reviewer Recommendation Term:	Revise with Major Modifications
Overall Reviewer Manuscript Rating:	75

Custom Review Questions	Response
Is the subject area appropriate for you?	5 - High/Yes
Does the title clearly reflect the paper's content?	4
Does the abstract clearly reflect the paper's content?	3
Do the keywords clearly reflect the paper's content?	5 - High/Yes
Does the introduction present the problem clearly?	3
Are the results/conclusions justified?	1 - Low/No
How comprehensive and up-to-date is the subject matter presented?	4
How adequate is the data presentation?	N/A
Are units and terminology used correctly?	4
Is the number of cases adequate?	N/A
Are the experimental methods/clinical studies adequate?	4
Is the length appropriate in relation to the content?	1 - Low/No
Does the reader get new insights from the article?	5 - High/Yes
Please rate the practical significance.	4
Please rate the accuracy of methods.	N/A
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	3
Please rate the appropriateness of the references.	3
Please evaluate the writing style and use of language.	3
Please judge the overall scientific quality of the manuscript.	2
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

The authors present a novel method of performing EVAR using a technique that has the potential to reduce both radiation exposure and contrast volume. This may be particularly useful during complex EVAR procedures which may involve high volumes of both.

The virtual reality platform is an extremely interesting and novel method of performing aortic vascular intervention. Most readers will be interested to know the safety profile of using this system and also whether there are efficiencies to be had beyond saving on radiation and contrast. Unfortunately, this manuscript does not present either.

Whilst this paper is presented as a study in IMRaD format it does not state or test a hypothesis, nor does it present objective data endpoints. In this reviewer's opinion it would be better rewritten as a technical note, case series or narrative review.

Some points which may be worth considering:

1. Introduction is far too long. The background history of triple-A and EVAR could be truncated.

2. There is a thorough explanation of the system which assists the reader in understanding its complexity. However, this could also be shortened without losing too much information.

3. Results. These aren't actually results, they are further description (and figures) of the equipment used in the system.

4. Some data would be useful. What experiments were conducted on the models? How long did they take? How long did it take for skills to develop in the operators? What modifications were made during early experimentation? What is next? Animal or Early human trials? Whilst the concepts are interesting it would be useful to understand the utility and applicability of the system.

Reviewer 2: Heiner Wenk

Aug 14, 2018

Reviewer Recommendation Term:	Accept
Overall Reviewer Manuscript Rating:	80

Custom Review Questions	**Response**
Is the subject area appropriate for you?	2
Does the title clearly reflect the paper's content?	4
Does the abstract clearly reflect the paper's content?	4
Do the keywords clearly reflect the paper's content?	4
Does the introduction present the problem clearly?	4
Are the results/conclusions justified?	4
How comprehensive and up-to-date is the subject matter presented?	4
How adequate is the data presentation?	4
Are units and terminology used correctly?	4
Is the number of cases adequate?	N/A
Are the experimental methods/clinical studies adequate?	4
Is the length appropriate in relation to the content?	4
Does the reader get new insights from the article?	5 - High/Yes
Please rate the practical significance.	3
Please rate the accuracy of methods.	4
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	3
Please rate the appropriateness of the references.	4
Please evaluate the writing style and use of language.	4
Please judge the overall scientific quality of the manuscript.	4
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

The reviewer hinself has no experience in Navigation an visualistation with hololens in endovascular surgery. Nevertheless, this seems to be a method to avoid Radiation exposure during arotic suergery. In my opinion important Research.

Authors' Response to Reviewer Comments

Aug 24, 2018

First, we would like to thank the anonymous reviewers for their valuable comments and constructive criticism to this article. We have added several modifications to the manuscript to address their suggestions. As requested, we have submitted our revised manuscript highlighting the changes: the new text was marked in red colour and the removed one is shown on the right side entitled "Deleted".

Next follows a point-by-point reply to the reviewers' comments. Reviewers' comments:

Reviewer #1:

- The authors present a novel method of performing EVAR using a technique that has the potential to reduce both radiation exposure and contrast volume. This may be particularly useful during complex EVAR procedures which may involve high volumes of both.
The virtual reality platform is an extremely interesting and novel method of performing aortic vascular intervention. Most readers will be interested to know the safety profile of using this system and also whether there are efficiencies to be had beyond saving on radiation and contrast. Unfortunately, this manuscript does not present either.
Response: the reviewer pointed out two important aspects of the research in this field (namely to quantify the reduction on radiation dose and contrast agent, and if there is any other improvement in endovascular aortic repair (EVAR) procedures when using our approach). Our manuscript was focused on describing the technologies involved in an ongoing research project with funds for two years more and presenting an initial evaluation of those systems, showing their advantages and some limitations to be solved. Quantification of the factors mentioned by the reviewer belongs to a further state of this research project when having a more completed version of our prototype.
- Whilst this paper is presented as a study in IMRaD format it does not state or test a hypothesis, nor does it present objective data endpoints. In this reviewer's opinion it would be better rewritten as a technical note, case series or narrative review.
Response: the last paragraph of the introduction was modified to address the reviewer's comment.
- Some points which may be worth considering:
1. Introduction is far too long. The background history of triple-A and EVAR could be truncated.
Response: several lines were removed from the "Introduction" section to facilitate the reading.
2. There is a thorough explanation of the system which assists the reader in understanding its complexity. However, this could also be shortened without losing too much information.
Response: several lines were also deleted from the "Materials and methods" section to facilitate the reading. Three specifications of Microsoft HoloLens (namely wireless, 579 g and 2-3 hours) were added to the "Introduction" and "Discussion" sections in order not to remove these details from the manuscript.
3. Results. These aren't actually results, they are further description (and figures) of the equipment used in the system.
Response: the authors do not completely agree with the reviewer since the "Results" section includes an evaluation of the systems presented in this manuscript (namely the validation that the new external markers were visible in computed tomography (CT) scans, the creation of a virtual angioscopy from the aortic-aneurysm phantom following the method presented in the "Augmented reality" section, the check of the navigation workflow and its visualisation with HoloLens using the FAST Ultrasound Training Model and a tracked catheter, and the results of the latency between sending a volume from the US system and its visualisation on HoloLens).
Our further research will include, for instance, the quantitative assessment of the target registration error with the non-rigid aortic-aneurysm phantom by means of acquiring a CT or cone-beam CT scan of the whole setting (phantom and tracked catheter) during the navigation.
4. Some data would be useful. What experiments were conducted on the models? How long did they take? How long did it take for skills to develop in the operators? What modifications were made during early experimentation? What is next? Animal or Early human trials? Whilst the concepts are interesting it would be useful to understand the utility and applicability of the system.
Response: the experiment conducted on the aortic-aneurysm phantom was checking the creation of a virtual angioscopy from a CT scan of this model, which was built from different materials. This explanation was included in the "Evaluation" section. On the other hand, the experiment carried out with the FAST Ultrasound Training Model was checking the navigation workflow with a tracked catheter and its visualisation with HoloLens.
In the experiments conducted on the models we did not measure the time that these experiments took since we did not consider that information was quite important for the reader since these experiments involved acquiring CT scans, processing those studies to obtain the virtual angioscopy and to create virtual 3D objects (namely the surface of the phantom and the vessels), and carrying out the navigation with the tracked catheter. We will consider measuring that time in future research.

The experiments carried out were done by the researchers in charge of developing the systems shown in this study. Therefore, no information regarding the time that it would take the operators to manage the system presented in this study is available. Our idea is to develop a user-friendly and intuitive interface to facilitate its use by clinicians. We will consider evaluating the factor mentioned by the reviewer in future research. Regarding the modifications done in early experimentation, we apologise for not giving any response since we do not understand what the reviewer is referring to. Some modifications from the initial prototype to that presented in this study were detailed in the "Materials and methods" section.

The next steps of the research project are to get through the limitations of the current solution detailed in the "Discussion" section (for instance, to update navigation with the patient's current anatomy during EVAR procedure or to obtain a shape reconstruction of the endovascular tool) before carrying out animal or early human trials. Our approach is to do the experiments with our aortic-aneurysm phantom since it includes a non-rigid patient-specific aortic model that can also be exchangeable for other 3D-printed aortoiliac pathologies.

Reviewer #2:

The reviewer himself has no experience in Navigation a visualization with HoloLens in endovascular surgery. Nevertheless, this seems to be a method to avoid Radiation exposure during aortic surgery. In my opinion an important research.

Response: the authors thank the reviewer for their comment regarding the quality of the research.

Additions and corrections done by the authors:

Some text was corrected in the "Conclusion" paragraph of the "Abstract" section and in the last paragraph of the "Discussion" section.

A sentence in the "Augmented reality" section was rewritten to improve the reading.

Some text was included in the "Aortic aneurysm phantom" section to specify that the patient-specific aortic model is not rigid in case readers do not know the properties of the materials used to build this phantom.

Reviewers' Comments to Revision

Reviewer 1: anonymous

Aug 28, 2018

Reviewer Recommendation Term:	Accept
Overall Reviewer Manuscript Rating:	75

Custom Review Questions	**Response**
Is the subject area appropriate for you?	5 - High/Yes
Does the title clearly reflect the paper's content?	4
Does the abstract clearly reflect the paper's content?	4
Do the keywords clearly reflect the paper's content?	5 - High/Yes
Does the introduction present the problem clearly?	3
Are the results/conclusions justified?	3
How comprehensive and up-to-date is the subject matter presented?	4
How adequate is the data presentation?	3
Are units and terminology used correctly?	3
Is the number of cases adequate?	3
Are the experimental methods/clinical studies adequate?	3
Is the length appropriate in relation to the content?	3
Does the reader get new insights from the article?	5 - High/Yes
Please rate the practical significance.	4
Please rate the accuracy of methods.	4
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	4
Please rate the appropriateness of the references.	4
Please evaluate the writing style and use of language.	3
Please judge the overall scientific quality of the manuscript.	3
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

The authors seem to have made appropriate changes to the manuscript, where possible.