Peer Review File

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Reviewer A

This report was very interesting, but it has some limitations that are addressed below.

Major comments

1. This manuscript described the usefulness of the 3D printed simulator for only right lower anterior basal segmentectomy (S8). Why did the authors select the S8 segmentectomy to assess the usefulness of the 3D printed simulator? I wondered whether the authors performed other types of segmentectomy. While the S8 segmentectomy is thought to be a relatively simple procedure, complex segmentectomies like S9+10 segmentectomy etc. are more challenging than other segmentectomies. It is interesting whether it is possible to learn such a challenging segmentectomy by using this simulator. Therefore, I think that it is better to also describe the usefulness of this simulator for not only S8 segmentectomy but also various segmentectomies because the simulator is assumed to be available for various segmentectomies.

Response question 1:
We thank the reviewer for their comment. The 3D printed simulator can be used for the training of diverse pulmonary resections such as atypical wedge resections, segmentectomies or lobectomies. Segmentectomies have been classified as complex and simple. For example, Segment 6, basal segment (segments 7-10 or 8-10), lingual (segments 4-5 left) or culminal (segments 1-2-3 left) are generally considered as simple segmentectomies. On the contrary, segment 1, 2, 3, 7, 8, 9 and 10 are generally considered as complex[1, 2.]
We thus chose to illustrate our approach with a complex segment. In addition, the silicone insert has a certain rigidity as discussed in the discussion making a postero-basal approach a bit more challenging (i.e segment 9 or 10 resection). In the revised manuscript we explain these elements more precisely and discuss the need for a softer insert to improve the training of basal segmentectomies. We have specified these elements in the revised manuscript.

Changes question 1:
Line 170-172:
"We chose to illustrate a S8 segmentectomy, however this 3D-printed model can also allow the training for all other types of segmental pulmonary resections.

Line 222-226:
"Some elements still require improvement: the rigidity of the silicone parenchyma remains problematic. We have noticed that the training of basal or posterior segmentectomies was more challenging for exposure in the model. This type of issue could be overcome by the development of an insert with a softer silicone".

2. What is the cost of this 3D printed simulator? Of course, although I think this simulator is very useful, it is important to also discuss the cost of this simulator.

Response question 2:
We thank the reviewer for the pertinent comment. The estimated annual costs for the simulator, inserts and material (staplers/harmonic) is of 56000CHF/year. Each insert can be used several times for the training of lower and upper lobe segments. As described later, this training program was possible with the support of the industry namely Ethicon Johnson and Johnson. We have detailed these elements in the revised manuscript.

Changes question 2:
Line 217-218: "The costs of such an approach could be covered by industry sponsoring (see conflicts of interest) and the inserts could be used for more than one procedure."

3. In the author's institution, what is the goal of this simulator? I felt that the author's description of a training program for VATS segmentectomy was slightly vague. What is the time-frame for training before an actual VATS segmentectomy for real lung cancer patients? It may be interesting to assess not only the satisfaction of the trainees for this simulator, but also a grade scoring of the trainees who experienced the simulator before the actual VATS segmentectomy.

Response question 3:
We thank the reviewer for the comment. In our institution, we deliver mandatory simulation training courses on a weekly basis. These courses are supervised by board trained surgeons and have become a routine for our residents. We have a panel of simulators including the Stupnik described in this manuscript but also perfused lobectomy training simulators, laparoscopy training simulators and fully virtual training systems. In a separate study which is currently being reviewed, we have found that the objective performance of trainees was significantly improved compared to controls with this weekly training program.

Changes question 3: No changes performed to the manuscript as this element is stated (lines 199-202) "In our institution, we have integrated these course on a weekly schedule and have made them mandatory. It will be essential in the near future to assess objectively how such courses impact the performance of trainees on real cases. A study is currently being planned with this objective".

Minor comments

1. I think that it is better to revise the describing "right lower lobe segment 8 resection" on the lines 1, 47-48, 53, 100, 132, 140, and 143 to "right lower anterior basal segmentectomy (S8)" to make the words easier to understand .

Response and changes comment 1:
We thank the reviewer for the comment. We have changed the manuscript and modified *"right lower lobe segment 8 resection" to "right lower anterior basal segmentectomy (S8)"* throughout the text.

2. In the line 74, I think that it is better to describe the abbreviation of NSCLC as non-small cell lung cancer.

Response and changes comment 2:
We thank the reviewer for the comment. We have made the suggested change. The manuscript now reads (line 72): "The surgical approach of non-small cell lung cancer (NSCLC)"

Reviewer B

The authors have reported teaching methods for residents using three-dimensional lung model simulators for anatomical segmentectomy. They concluded that their simulation approaches were useful for the teaching of residents and should be better integrated in the curriculum of trainees. However, from the contents of the article, it is not possible for readers to evaluate the actual training, the running of vessels or bronchus. Furthermore, we cannot determine whether the model is really capable to perform anatomical resection. These parts are an important point of this paper because it is a core technique of training. Therefore, authors should provide details of the 3D printed models which readers can detect the vessels or bronchus.
The authors also should provide the movies of actual training which trainee and trainers were performing anatomical resection using 3D model.

Response question 1:
We thank the reviewer for his comment. The 3D silicone printed model contains the anatomy of the vasculature (arteries/veins) and also of the bronchi which are accurate in 3D. To illustrate better the type of insert we have used, we have replaced a figure (Figure 1A right panel) to show the anatomy of the insert without the silicone. This 3D anatomy is the important element for the training of lobectomy of segmentectomy. Indeed, independent of the chosen approach (anterior/trans fissure or posterior), it is possible to understand how the vein/artery and bronchi are located from specific anatomical landmarks. Regarding the video, the one we provide is that of a trainee performing the surgery on the 3D insert and supervised by the trainer.

Changes question 1:
We have changed the right panel of Figure 1B. We have also modified the figure and video legends lines 267-272 "1A: Stupnik® 3D insert representing a right lung with the integrated representation of veins, arteries and bronchi. The upper, middle and lower lobes are represented by the letters U, M and L respectively. 1B: The silicone is removed to show the venous (blue arrow), arterial (white arrow) and bronchial systems (yellow arrow). The latter respect the standard anatomy of these systems in the insert. 1C: Aspect of the simulator with a closed chest and the placement of the alexis mini and thoracoports. 1D: instrumentation for the making of the video" and video legend: "… performed by a trainee and supervised by a staff surgeon. The steps of the resection are described with an anterior trans-fissure approach".

Reviewer C

Indeed, we share the same main message behind this article; simulation represents a very important key of modern surgical training.
However, we have the following remarks to make.

1- English language proof reading
I highly suggest that the authors review the article with a native English speaker.
To cite some of the phrases that need rewording.:

Line 54 Harmonic grasper. I would rather use shears (as described by J&J) or device, rather than grasper.

Lines 61-62 The approach was satisfactory for residents which found the exercise…
Residents who not which.

Line 110 moose. Please find definition here
https://www.collinsdictionary.com/dictionary/english/moose

Line 120 Optic device. You mean Scope?
I would rather use 10-mm 30° thoracoscope/Scope.

Line 123 MVS staplers? Can you please define the abbreviation MVS? It's not mentioned elsewhere in your manuscript.

Line 152 We mounted A8 and staple/devided it.
Mounted vs dissected?.
devided is written with an I (divided).

Lines 170-172 This was possible with the use of a 3D printed lung that can be dissected in a similar way to a patient and which has facilitated and still realistic anatomical landmarks.
Too many (Ands). Please rephrase.

Lines 203-204 Finally, we believe that the integration of such a program as a mandatory period of trainees helped take most advantage of the plateform.
Period of trainees? Or training?
Plateform vs platform

Response question 1:
We thank the reviewer for the comment and have reviewed the manuscript with a native English speaker and corrected where necessary (highlighted in yellow in the text).

2- Course organization lines 125-129.
It's not clear for the reader, for long have you been doing this? A year for e.g.?

Did you take in consideration the total duration required for a resident to finish the procedure? Establish a learning curve?

Response question 2:
We thank the reviewer for their comment. We have included VATS simulation courses as part of the training curriculum in our institution for the past two years. All residents have this mandatory practice as a complement to their exposure in the operative room. Residents train in dyads and either assist or perform a given procedure. The sessions generally last one afternoon (4 hours) and have progressive levels of complexity: residents first work lung exposure, simple atypical (wedge) resections, lobectomy and finally segmentectomy. The time allowed for training is generally sufficient as the objectives increase progressively. In a separate trial, we determined the objective impact of this training program on resident movement performance. The latter was significantly improved (manuscript in preparation). We have not established a learning curve given we did not record all procedures. However, the general impression is that young residents are subjectively more comfortable with instrument and lung handling and understand the anatomy better. We have not established a learning curve.

Changes question 2:
Lines 123-128 "The courses took place on weekly basis lasting 4 hours with two residents learning to perform the procedure (6 residents in total) supervised by one fellow or staff surgeon. Each resident was operator or assistant for the procedure once. At the end of the course, the residents filled a satisfaction questionnaire".

3- Out of curiosity, why did the authors choose segment 8 please?
As a thoracic surgeon, this is one of the rare segmentectomies to carry out.
Why not Segment 6 for e.g.?

Response question 3:
We thank the reviewer for his comment. We chose segment 8 as it is unusual and considered as a complex type of segmentectomy procedure. As discussed with Reviewer 1 Question 1, the model allows the training of virtually any kind of segmentectomy. However, the rigidity of the silicone implant make posterior and lower lobe segments more complex.

Changes question 3:
Line 170-172:
"We chose to illustrate a S8 segmentectomy, however this 3D-printed model can also allow the training for all other types of segmental pulmonary resections.

Line 222-226:
"Some elements still require improvement: the rigidity of the silicone parenchyma remains problematic. We have noticed that the training of basal or posterior segmentectomies was more challenging for exposure in the model. This type of issue could be overcome by the development of an insert with a softer silicone".

4- Video recording.
Line 134, using Microsoft … without the name of the video editor.
The phrase seems to be unfinished.

Response question 4:
We thank the reviewer for the comment. The sentence was indeed incomplete. The program used was Filmora9 from Wondershare coorporation limited (Lhasa, China)

Changes question 4:
Line 130-132: "The procedure was recorded on the Stryker® video thoracoscopy tower and edited using Filmora9 (Wondershare corp ltd, Lhasa China)".

5- Video material. Line 143.
Good video. I would suggest adding a video of a resident's first attempt, and the last one at the end of the course for comparison.

Response question 5:
We thank the reviewer for his comment. We unfortunately did not record the resident's first and last attempts for comparison. As the courses were performed in the presence of a staff surgeon, the feedback was given during the training procedure.

Changes question 5:
No changes

6- Results
Line 145, there is no mentioning of A4. Is there one common middle lobe artery in your model please?

Response question 6:
We thank the reviewer for the comment. The 3D printed model has all segmental veins/arteries and bronchi for the right lobe. The reason A4 is not mentioned in the text is it is difficult to visualize from the great fissure without dissecting more proximally. Given the video aims to show the steps of segment 8 resection, we did not find important to demonstrate the location of A4.

Changes question 6:
We have not made any changes to the manuscript for this comment.

7- Discussion
This system represent a first of many learning steps.
As much as I agree with the authors that this model enhances dexterity, scope handling, anatomical knowledge..etc. I genuinely think that one can't say with that this model would enhance residents' performance in segmentectomy. Authors are invited to provide further proof (operative duration, precise learning curve) and show how do the acquired skills translate in the real operative world, or kindly change their phrase to reflect the main advantage of such simulators.

Response question 7:
We thank the reviewer for the comment. We agree that we do not provide evidence that such a training approach improves the performance of residents. We have therefore changed the wording in the discussion and give our subjective impression on our simulation approach. We have completed a separate trial where we observed the objective performance of residents with and without a simulation training program. We have found a significant improvement with the training program (manuscript in preparation).

Changes question 7:
We have modified the first portion of the discussion section which now reads: line 162-168 "We report a novel training simulation training approach for residents to improve their performance for minimal invasive segmentectomy. This was possible with the use of a 3D printed lung that can be dissected in a similar way to a patient facilitating the recognition of anatomical landmarks. Overall, we believe the model allows 3D orientation in a chest, instrument placement and lung exposition, step by step structure identification and isolation, parenchyma sectioning and stapling. Resident satisfaction was great. We believe that this approach could be a useful adjunct in the training programs of residents. We chose to illustrate a S8 segmentectomy, however this 3D-printed model can also allow the training for all other types of segmental pulmonary resections".

8- Conclusion
Lines 254-255 For this reason, we have established weakly training sessions for young surgeons of our division.
Weakly vs weekly?
Do you train your young surgeons every single week on this model to do the same segmentectomy? Please clarify.

Response question 8:
We thank the reviewer for the. We have corrected the typo mistake and have better specified our concluding remark. We have established a simulation training program in our division where trainees participate and complete increasingly complex exercises on a weekly basis. These courses start with instrument handling, lung exposure, camera management. We then perform atypical resections on lungs followed by anatomical lung resections (upper/lower/middle lobectomies) and follow with simple/complex segmental resections.

Changes question 8:
We have changed the last sentence of the conclusion: line 248-250 " For this reason, we have established a training course with increasingly complex objectives that are performed by trainees of our division during weekly simulation sessions".

9- Funding.
I can't help but noticing that Harmonic, Stupnik, and the staplers are all produced by Ethicon. Can you add a funding section to clarify whether J&J finances this training program please?

Response question 9:
We thank the reviewer for his comment. Ethicon (Johnson and Johnson) do support financially this training program. We have thus modified the conflicts of interest and included this important element

Changes question 9:
Line 28-29: "Ethicon (Johnson and Johnson) have financed the training laboratory we have used in this study"

Reviewer D

Congratulations on a nice paper regarding use of simulators for training. This is increasingly becoming more important with the changes in structure of training, working hours as well as increasing complexity of cases and patients seen.

For me there are a few small questions:

1. Apart from satisfaction surveys, are there more objective surveys for the trainees regarding the use of these simulators?

Response question 1:
As answered to other reviewers, in the present study we did not focus on other aspects than resident satisfaction. However, we have completed a second study for which we are completing the manuscript where we show that a well established simulation training program allows trainees to objectively improve their performance. This is not surprising but reassured us in our subjective impression of the positive impact of a simulation program.

Changes question 1:
No changes

2. The length of the training course is not mentioned, along with the number of hours per session. perhaps you could add a bit more detail about how it has been integrated into the training course.

Response question 2:
We thank the reviewer for his comment. The training sessions took place for a period of 6 months with weekly sessions of resident dyads training for 4 hours. For each session, the trainee was either performing the surgery on the simulator or assisting.

Changes question 2:
We have added the schedule and length of training in the methods section. Lines 123-126 "The courses took place on weekly basis lasting 4 hours with two residents learning to perform the procedure (6 residents in total) supervised by one fellow or staff surgeon. This simulation training was performed for 6 months"

3. It would be nice to have an objective assessment for the trainees in performing real cases (I.e. assessment scores pre- and post- simulator training). That will add some weight to this paper.

Response question 3:
We thank the reviewer for his comment. As discussed, we have not assessed the performance of trainees with the training sessions on real cases. We have a study planned to determine these elements.

Changes question 3:
We have added a comment in the discussion section which now reads: line 198-200 “It will be essential in the near future to assess objectively how such courses impact the performance of trainees on real cases. A study is currently being planned with this objective”

4. There are some grammatical errors throughout the paper which should be corrected prior to publication. These include sentence construction.

Response question 4:
We thank the reviewer for their comment. We have reviewed the article with a native English speaker and corrected the mistakes.

References

1. Handa Y, Tsutani Y, Mimae T, Miyata Y, Okada M Complex seg- mentectomy in the treatment of stage IA non-small-cell lung cancer. Eur J Cardiothorac Surg. 2020;57(1):114-121.
2. Handa Y, Tsutani Y, Mimae T, Tasaki T, Miyata Y, Okada M Surgical outcomes of complex versus simple segmentectomy for stage i non- small cell lung cancer. Ann Thorac Surg. 2019;107(4):1032-1039.

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