Peer Review File

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Reviewer A:

Comment: Chen et al. illustrated the current AI-assisted display applications based on CT in thoracic surgery and proposed its potential development process based on surgical video in this article.

This manuscript is well written and interesting. I learned a lot from this article.

I don't have any further questions and comments.

Response：Thank you for your kind comment. We hope this review could contribute to the research field of AI and lung cancer surgery to some extent.

Reviewer B:

Comment 1: The main contribution of this publication is a review of research that has been performed in the space of Artificial Intelligence aided display applications based on computed tomography for Thoracoscopic surgery. The authors observe that AI based systems have potential to help overcome hurdles in Video Assisted Thoracoscopic Surgery (VATS) while noting that the AI-related contributions are still minor. The review is aimed at spurring interest from researchers in the field. The authors are to be congratulated in making the above observations and making the contribution of reviewing the methods and systems that currently exist in this area.

Here are a few points of improvement: The title, as it stands, is awkward and can be re-worded. For example, you can change 'possibility' to 'possibilities' and 'development process' to 'progress' or 'recent development' or vocabulary that is similar.

Response 1：Thank you for your valuable suggestions. We have adjusted the vocabulary of the title as the revised manuscript shows (pages 1, line 4).

Change in the text: Artificial Intelligence Assisted Display in Thoracic Surgery: Development and Possibilities.

Comment 2: It would be helpful to know the methods used in performing the review such as information on what libraries were searched, the number of titles screened and so on. It would also be helpful to report any high-level findings of the literature survey such as comments on the general performance of the models, its acceptance by the surgical community and future directions.

Response 2：Thank you for your valuable suggestions. We have added the methods used in performing the review. Besides, we also collected the relevant high-level findings of the literature survey and presented in tables. The relevant content was added in the revised manuscript. (Page 5-6, 107-118 and table1-3).

Change in the text: Here, we focus on the AI-related display for surgical assistance in lung cancer surgery by reviewing AI's integration with CT and anticipating its combi-

nation with surgical videos. This narrative review is based on research material obtained from PubMed up to July 2021. The search terms include “artificial intelligence”, “thoracic surgery”, “three-dimensional reconstruction”, “virtual reality”, “augmented reality”, “mixed reality”, “computer tomography”, “surgery”, and “videos”, etc. Those most relevant and interesting are fully reviewed. In particular, we used search strategy “(artificial intelligence [MeSH Terms]) AND (thoracic surgery [MeSH Terms])". In the last five years, we found that there has been no AI-based research in thoracic surgery videos except for one is based on laryngoscopy and bronchoscopy videos (24). Most surgical AI research focuses on laparoscopic surgery (25-28). The reason may be that the thoracic surgery videos are more difficult for traditional AI to apply than other surgery due to the higher complexity of the procedure.

Commenter 3: The writing style is generally awkward: for example, in line 6, ‘…Given that the development of AI in other surgical fields shows promising…’, the phrase ‘shows promising’ should be changed to ‘shows promise’.
Response 3：Thank you for your valuable comment. To solve this problem, we have reviewed the manuscript and tried to make the writing style more concise. Please reviewed the whole revised manuscript again.

Reviewer C:

First of all, I thank the authors for their contribution to this very interesting and quickly evolving field of technology-based medicine. The development of AI is an interesting topic and its application within medicine is of importance, as it might transform certain medical specialties that require algorithmic thinking and workflow. However, despite their good intention, they do not really succeed in translating this into the manuscript. At the moment, the manuscript reads like it does not live up to the expectation sparked from the title and the actual discussion regarding the topic of artificial intelligence (AI) and I feel the manuscript needs major revisions for it to accomplish the perceived intentions of the authors by discussing the topic. Below I try to provide directions for doing so.

Comment 1: The flow of the manuscript feels illogical and incomplete. I feel the manuscript would benefit from a clear structure and build-up before addressing the relevant information regarding the application of AI within thoracic surgery. I would propose to start with a general explanation of what AI actually is, what is needed to build an AI-algorithm (machine learning, records from databases, etc), how AI-technology is currently being translated into medicine (i.e. within radiology, pathology, etc), and finally, how this might be applicable to thoracic surgery. The different steps should in

turn be supported by relevant literature regarding the subject and culminate into a conclusion regarding the potential and future directions of AI-technology within thoracic surgery.

Response 1：Thank you for your valuable suggestion and we believed that your suggestion would be of great help to our manuscript. Therefore, we have added more content to improve the logic of our manuscript and make the structure clearer. Please reviewed the whole revised manuscript again.

Comment 2: I feel the authors confuse 3D-reconstruction and the techniques to do so with AI. To be clear, 3D-reconstruction of 2D-images is not a form of AI. AI, according to the dictionary, is 1. A branch of computer science dealing with the simulation of intelligent behavior in computers, or 2. The capability of a machine to imitate intelligent human behavior. The mere act of reconstructing an image into a 3D-simulation is not related to AI, although it might serve to assist in building an AI-algorithm and might be a tool AI can utilize to assist during surgery (for instance through AR or MR). The entire first paragraph therefore feels quite out of place and unrelated to the topic the authors intent to discuss.

Response 2：Thank you for your kind comment. We agree with your view point that AI is 1.A branch of computer science dealing with the simulation of intelligent behavior in computers, or 2. The capability of a machine to imitate intelligent human behavior. Therefore, according to the definition, all could independently and automatically carry out construction or projection of surgical images and models based on medical imaging without artificial assistance were classified as AI. For example, some recent 3D reconstruction networks are based on CNN semantic segmentation. So, we included 3D reconstruction as an important part of our review.

Comment 3: After reading the manuscript, its still not clear to me what the authors think the potential of AI within thoracic surgery exactly entails. The recognition of instruments and surgical phases seems of no added value, as this is not something a surgeon would profit from during surgery. Because the added value remains vague, the manuscript reads like the authors had a specific goal in mind before (being: to prove the added value of AI), instead of trying to provide an overview of the available evidence and then decide upon the added value of this technique, or not. The latter would be more in line with the principals of scientific conduct, now it reads like there is an underlying agenda and the authors try to convince their audience into agreeing with them. A more objective and critical approach towards the topic would be recommended.

Response 3: Thank you for your kind comment. In this major revision, we reorganize the manuscript that emphasizes the core idea of AI-assisted display applications in

thoracic operation based on CT and surgical videos. The CT images and surgical videos have routinely accumulated as a large and informative surgical data source and they are valuable resources for developing surgical applications. And AI is a powerful and promising tool for realizing those applications.

Take lung cancer surgery as an example, preoperatively localizing lung nodules precisely, intraoperatively identifying anatomical structures accurately, and avoiding complications requires a visual display of individuals' specific anatomy for surgsical simulation and assistance. Vividly revealing individuals' anatomy and anatomical variations is one of the greatest application for AI when it combines with CT imaging, which will greatly improve surgical efficiency and safety.

Now AI-assisted display based on surgical videos is a new surgical application and was initially applied to other surgical fields like cataract surgery, gynecological surgery, and laparoscopic surgery. However, it is not yet clear that what the potential applications and development of surgical videos are, especially in thoracic surgery. This narrative review is based on research material obtained from PubMed up to July 2021. In particular, we used search strategy "(artificial intelligence [MeSH Terms]) AND (thoracic surgery [MeSH Terms])". In the last five years, we found that there is no AI-based research in thoracic surgery videos except for one is based on laryngoscopy and bronchoscopy videos. The reason may be that the thoracic surgery videos are more difficult for traditional AI to apply than other surgery due to the higher complexity of the procedure. Therefore, surgical AI applications based on videos in thoracic surgery remain a vacuum and its possible developing process captures the imagination of thoracic surgeons.

We think that AI-assisted display based on thoracic surgical videos has significant meanings. Surgical videos are a common surgical data while little was explored in the qualitative or quantitative analysis regarding surgical context like bleeding in a crucial phase, significant anatomical structure injury, completeness of lymph node dissection, surgical steps and order, and operation duration, etc. The intraoperative information itself remains as a black box for thoracic surgical application. With the further development of AI, computer vision (CV), one of the AI architects, enables computers to learn and predict visual patterns in pictures and videos. The AI algorithms can decode the whole surgical video contexts in a measurable way to display intraoperative events for many applications by following the underlying procedures we proposed.

We also assume some potential applications. The first application is surgical education and training. Lobectomy and even segmentectomy are complex, difficult for thoracic surgeons in their early careers. AI-based commentary of surgical videos is one of the solutions. The second one is operation quality evaluation. Instead of being empirical to assess one expert's surgical skill as we do in effect, AI could provide a more precise measurement of surgical quality by identifying how much blood loss, how much time spent in dealing with the bronchovascular stump, how much lymph nodes and stations were dissected, and so on. The third is intraoperative assistance. Though a qualified thoracic surgeon won't need the help of AI to recognize anatomy, the comprehensive evaluation of disease severity and precise prediction of complications (e.g., bleeding or accidental injure) in real-time for quality assurance would be necessary. Last but not least, the postoperative analysis. Differ from the clinical models that merely consider perioperative variables for prognosis prediction, the surgical AI can decode the whole surgical video contexts in a measurable way to identify underlying intraoperative factors (e.g., time in dissecting lymph node or the sequence of different anatomical structure management) that affect prognosis. Quality evaluation of surgery is supposed to be associated with the recovery and mortality of patients.

On the whole, we illustrated the current AI-assisted display applications based on CT in thoracic surgery; focused on the emerging AI applications in thoracic surgery based on surgical videos by reviewing video-based AI-assisted display researches in other surgical fields and anticipate its potential development in thoracic surgery which including the construction of videos database, annotation of surgical data, identification of instrument and anatomic structure, and automated recognition of surgical phases.

Comment 4: The report affiliations of the authors suggest that no author with a solid background within AI participated into the construction of the manuscript. Perhaps it would be advisable to involve someone with expertise within the field of AI in the construction of the manuscript.

Response 4: Thank you for your kind comment. Zeping Yan is a co-author of this manuscript. He graduated from the University of Edinburgh, UK and majored in mathematics and statistics. Since then, he has been worked as an AI algorithm engineer in our center and committed to the research and development of artificial intelligence in thoracic surgery. Moreover, he has published several articles related to artificial intelligence. He was full involved in the construction, writing and review of this manuscript.

Comment 5: Although the general level of academic English is acceptable, it would be advisable to involve a native speaker in the proofreading of the final manuscript, as the general message of some sentences is, literally, lost in translation.

Response 5: Thank you for your valuable suggestion. We have improved the language of our manuscript by assistance from a native English speaker.

Comment 6: It would be nice if a short explanation of the followed methodology would be included in the manuscript, to shed light on how the authors conducted their search and came to their conclusions.

Response 6: Thank you for your valuable suggestion. At present, video-based surgical AI research show relatively high accuracy in instruments, anatomical structures, and surgical phase recognition in other surgical fields like cataract surgery, gynecological surgery, and laparoscopic surgery. However, to the best of our known, there are no AI-based research in thoracic surgery videos. So, we propose the development process of surgical AI in thoracic surgery based on the other surgical fields. To solve this problem, we have explained the current situation in the “Introduction” part and summarize specific information about the relevant surgical-AI studies of other surgical fields in Table 2. The relevant content was shown in the revised manuscript. (Pages 6-7, lines 106-116, Pages 9, lines 195-199, and Table 2)

Change in the text: The CT images and surgical videos are the common clinical data associated closely with thoracic surgery. Here, we focus on the AI-related display for

surgical assistance in lung cancer surgery by reviewing AI's integration with CT and anticipating its combination with surgical videos. This narrative review is based on research material obtained from PubMed up to July 2021. The search terms include "artificial intelligence", "thoracic surgery", "three-dimensional reconstruction", "virtual reality", "augmented reality", "mixed reality", "computer tomography", "surgery", and "videos", etc. Those most relevant and interesting are fully reviewed. In particular, we used search strategy "(artificial intelligence [MeSH Terms]) AND (thoracic surgery [MeSH Terms])". In the last five years, we found that there has been no AI-based research in thoracic surgery videos except for one is based on laryngoscopy and bronchoscopy videos (24). Most surgical AI research focuses on laparoscopic surgery (25-28).

In recent years, the accessibility of big data and the rise of deep learning (DL) potentially enable machines to understand clinical data, particularly surgical videos (23). At present, video-based surgical AI researches show relatively high accuracy in instruments, anatomical structures, and surgical phase recognition in other surgical fields like cataract surgery, gynecological surgery, and laparoscopic surgery (27,54-58) (Table 2), showing the potency of AI in the videos analysis of thoracic surgery.

Comment 7: As a final statement, I would like to address the hope that my comments won't discourage the authors from pursuing their intentions with this topic, as it is a highly relevant one and the field would benefit from a review that addresses the current state of AI-technology within medicine and thoracic surgery. I hope my comments will aid them in achieving to do so.

Response 7: Thank you again for your valuable suggestions. We convince that the modifications based on your comments have improved to some extent.

Comment 8: English needs a native speaking review. There are some sentences or parts of a section that need a refinement of the language although most of the work is perfect.

- In line 261, authors refer to a data from December 2021. This is a typo. Please, amend it to the adequate date.

Response 8: Thank you for your valuable suggestion. We have improved the language of our manuscript by assistance from a native English speaker.