Author's response to reviews

Title: Postoperative pain relief using intermittent intrapleural analgesia following thoracoscopic anterior correction for progressive adolescent idiopathic scoliosis

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Response to Reviewers Comments  
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We thank the reviewers for their thoughtful comments and suggestions on the journal paper submission. We have responded to each reviewer’s comments in detail below (reviewer comments are in italics and our responses are in plain text). The changes made in the manuscript as a result of the comments are highlighted in yellow.

Reviewer #1 – Marinus de Kleuver: This is an interesting and well written paper on post-op pain management after endoscopic anterior thoracic scoliosis correction. The authors have tried to meticulously identify the efficacy of an intra-thoracic intra-pleural anaesthesia using an in dwelling catheter placed next to the instrumentation, through which bolus anaesthesia is given. With some additional information it is suitable for publication.

Major compulsory Revisions:

1. The authors describe “only” 32 of 80 of 205 patients. The reason for selection was the lack of complete data in the other 48 patients. Some more info on these should be provided. Even though we do not have all their VAS scores, it would be interesting to know if these 48 were similar or different to the 32 who are described. E.g. in a worst case scenario all 48 could have had complete failure of their intrapleural anaesthesia, and had break through pain. If that was the case, the conclusions of the paper would be different. So please provide some metrics on these 48, eg demographics, absolute pain management failure rate with intra-pleural anaesthesia, even if it is not available at the detailed level of the cohort of 32.

Thank you for this suggestion to improve the paper. Extra information on this group and the total cohort in general has been added to the Results section (page 5 & page 6)

Results Page 5. “The remaining 48 patients (45 females, three males) reviewed, where data was insufficient for inclusion in the analysis, were similar to the study group of 32, with mean age 16.0 ± 1.8 years (range, 13.3-20.4). For this group, the chest drain was removed similarly at mean 60.0 ± 15.7 (median 48, range 48 – 96) hours after surgery. For this group it was noted there were no adverse events or complications relating to their intrapleural analgesia.”

Results Page 6. “There were no complications or adverse events relating to analgesia delivery methods found for the study group or in any of the total 80 reviewed medical records. On questioning the surgeons regarding the entire cohort (205 cases) since the intrapleural analgesia technique was introduced, neither surgeon could recall a failure or adverse event related to the method which in part contributed to their desire to publish on our experience with the technique.

2. Please comment on the length of time the chest tube was in place. In my experience many patients have pain from the tube, possibly because it irritates the pleura. Once the drain is removed, the pain often diminishes. Please include this in your analysis, i.e. did drain removal influence VAS scores?

Patients often report some shoulder tip pain from the chest drain which does not respond to IV narcotics and is eased by the intrapleural bolus. The shoulder tip pain ceases when the chest drain is removed on Day 2 or Day 3. A sentence referring to insertion of the chest drain has been added to the Methods section (page 3) and timing of the removal added to the Results section (page 5). Implications of the chest drain and its effect on pain has been added to the Discussion (page 9 and 10)

Methods Page 3. “After visualization of lung reinflation, a 20 French Gauge chest drain was inserted through a small additional anterior incision (used for the suction apparatus during the procedure), before closure of the final distal operative portal.”

Results Page 5. “The chest drain was removed at mean 61.1 ± 13.1 (median 59, range 48 – 91) hours after surgery when the haemoserous exudate was draining at less 150 mls per day.

Discussion Page 9. “With the chest drain removed at mean 61 hours after surgery, and the intrapleural catheter removed at mean 58 hours after surgery, these may both have contributed to the drop of mean pain scores in the 60-72 time period of Figure 5.”
Discussion Page 10. “Opiate usage decreased significantly between the second and third and third and fourth 24 hour periods and was lower again once the intrapleural catheter and chest drain were removed (Figure 6). This may suggest that the catheter and chest drains were a source of some pain but it is most likely a combination of the removal of these irritants and the normal course of rapid recovery after minimally invasive surgery. Patients often report some shoulder tip pain from the chest drain which does not respond to IV narcotics and is eased by the intrapleural bolus. It has been noted that the shoulder tip pain ceases when the chest drain is removed on Day 2 or Day 3. Patients are sent home on non-steroidal anti-inflammatories and paracetemol based medications.”

With the removal of the intrapleural catheter occurring at a similar time to the chest drain, it is difficult to differentiate between the effect of these two. It may be appropriate to alter Figure 6 to say removal of IPC and chest drain together so Figure 6 and Figure 6 Legend (Page 12) have been altered to this affect. It is our opinion that good pain management in the early couple of postop days with the multi-modal analgesia approach allows the rapid recovery and reduction of morphine use during the hospital stay. A sentence has been added to the Discussion (page 10).

Discussion Page 10. “It is our opinion that excellent pain management in the early couple of postoperative days with the multi-modal analgesia approach encourages rapid recovery and reduction of morphine use during the hospital stay. It also reduces the need to be prescribed prolonged usage of opiates after discharge home from hospital.”

3. Was the rate of chest drainage related to the effect? In other words, despite clamping the drain, of course the bupivacaine will be diluted by pleural effusion. If total chest drain output is high, one might expect more dilution and less effect of the bupivacaine.

This is a question others may also have, so additional detail has been added to the Methods section.

Methods Page 4. “Efforts are made to position the intrapleural catheter behind the parietal pleura with the tip delivered at least 5cm into the sub-parietal potential space towards the superior end of the spinal instrumentation. The bupivacaine bolus is therefore somewhat contained, to allow the anaesthetic to infiltrate and soak the region where the intercostal nerves exit the spine. With the pleural effusion pooling inferiorly in the chest, it is expected there would be a minimal dilutional effect on the local anaesthetic bolus.”

Minor essential revisions:

4. Technique: was the parietal pleura closed over the catheter?
No, the technique is described in more detail in Q3 above.

5. Why do the authors give a bolus bupivacaine and not continuous pump?
An additional 3 sentences have been added to the discussion to explain the decision to give a bolus as opposed to continuous infusion of local anaesthetic.

Discussion, Page 7. “The technique of giving an intermittent bolus as opposed to a continuous infusion of local anaesthetic, allows the delivery of a higher dose of anaesthetic and therefore a more concentrated effect to achieve a dense neural block and is in keeping with postoperative epidural practice. The chest drain is clamped for around 30 minutes during delivery of the bolus and at all other times functions normally to assist with the clearance of the pleural effusion. A chest drain under continuous suction would hinder the effectiveness of a continuous delivery of local anaesthetic so was considered inappropriate for patients after TASF.”

6. Can the authors comment on the possible effect of intra-pleural anaesthesia on the chest wall / rib cage pain due to the incisions/portals vs the visceral/parietal local spine pain?
An additional discussion point has been added to address this point.

Discussion, Page 8. “Postoperatively, patients don’t tend to complain of pain from the incisions/portals over their general spine pain. However the intrapleural anaesthetic bolus is able to freely flow in the pleural space so may have some effect on minimising pain originating from the
portals. With the patients receiving a multi-modal analgesia approach it is difficult to attribute how much the intrapleural analgesia may ease any portal incision pain over the effects of the PCA and additional non-opiate oral analgesia.”

7. It appears the PCA use declined after removing the catheter. This might imply that the catheter was a pain trigger. Please comment.
This point was covered in answer to Question 2

8. Did any of the patients have intercostal blocks?
The technique achieves partial intercostal blocks due to the positioning of the intrapleural catheter which has been fed under the parietal pleura to infiltrate a number of the intercostal nerves as they exit the spine. This additional detail was provided in answer to question 3 and can be found in Methods, Page 4.

Reviewer #2 – Tomasz Kotwicki: This paper presents one centre experience in postoperative pain management with peri-spinal bupivacaine after anterior thoracoscopic scoliosis correction. The issue is clinically important and the paper provides interesting data. The anterior scoliosis correction is performed nowadays less often comparing to the posterior one, so an experience of a specialized centre is worth to share. The results of anterior scoliosis surgery have been reported to be very positive when indications and anterior thoracoscopic surgery rules are strictly followed. The centre presenting the paper to be reviewed seems to have large experience in TASF. The data presentation is correct even if 32 patients only out of 205 could be analysed. The method of pain management endorsed by the centre revealed effective however, it required solid education of the nurse staff. Table 1 provides the nurse protocol and is a valuable completion of the paper. This reviewer’s opinion is that closing and opening chest catheter together with administration of local anaesthetic may be considered demanding in non-trained teams. Also, the VAS pain monitoring every hour is optimistic and justified even if not always realistic. The method of pain management described in the paper is certainly possible to be endorsed in a specialized hospital but not sure if it can be recommended in cases when anterior spinal surgery is done occasionally only. The reported mean duration of postoperative catheter analgesia of 2.5 days is in line with this reviewer’s experience concerning pain intensity following scoliosis surgery. This reviewer clearly supports the use of VAS in pain monitoring. The protocol developed in the centre is of great value for other teams seeking to introduce the method.

Minor revisions:

1. The presentation of the Figure 4 is confusing, at least for this reviewer. Why the percentages of frequency do not sum up to 100% but they exceed 100%? Isn’t it rather the number of boluses than the frequency (percentage of patients) on your Y axis?
Frequency on the Y axis refers to the number of times each possible pain score was reported by the patients at any time throughout their hospital stay. The X axis is the possible pain scores that could be reported by the patient on the VAS scale. As stated in the discussion (page 9) before a bolus (blue bars) the pain scores given most often were at the higher end (4-6) of the VAS Scale and after a bolus the pain scores reported (red bars) were most frequently from the lower scores (0-3) of the VAS Scale. To assist with clarity, the Figure 4 Legend (page 12) now states, “Histogram demonstrating the frequency that each possible pain score was reported throughout the hospital stay, before and after administration of the local anaesthetic bolus following TASF” The Y-axis Title has been changed to “Frequency of each pain score”
The manuscript (Discussion, page 9) has also been altered to, “Before a bolus, the pain scores given most often were at the higher end (4-6) of the VAS scale, with a shift of the distribution toward lower pain scores (0-3) after a bolus was given, with a substantial proportion of the group reporting zero pain scores after a bolus.

2. There is no analysis of the chest tube removal on pain and analgesia. Don’t the authors consider the chest tube itself being an important pain factor in adolescents mobilized for respiratory exercises in post-op period? Could the authors comment on it?
Thank you for raising this point, which was also raised by Reviewer 1. A sentence referring to insertion of the chest drain has been added to the Methods section (page 3 and 4) as well as a sentence in the Results section (page 5) regarding the removal of the chest drain. Implications of the chest drain are now included in the Discussion (page 9 & 10)
Reviewer #3 – Toru Maruyama: I enjoyed the manuscript regarding intrapleural analgesia after TASF for AIS. As the authors pointed out, to demonstrate the effectiveness of the intrapleural analgesia, it would be necessary to perform a prospective cohort or randomised trial comparing patient-controlled analgesia with and without intrapleural catheter usage.

Minor Essential Revisions

Anterior surgery for thoracic curve is less frequently performed worldwide. What is the authors’ indication for the anterior surgery and posterior surgery?

The indications for anterior versus posterior selective thoracic fusion surgery is of interest so the following has been added to the Methods section (page 3).

Methods Page 3. “The indication for this type of surgery as opposed to a posterior selective thoracic fusion were: Lenke type 1 with thoracic Cobb angle between 40 - 70°, minimum of 50% correction of main thoracic curve on fulcrum bending radiograph, correctibility of any lumbar compensatory curve on side bending radiograph, and T5-T12 thoracic kyphosis angle of < 40°.”

Discretionary Revisions

Even if it is not main subjects of this study, I’m interested in the surgical procedure. How many portals are used? How many and how much the extent ribs are resected? How to insert the screws into lumbar vertebra using thoracoscopy?

As noted, the surgical technique is not the focus of this paper and more detail regarding this can be found in the references provided in the manuscript, one of which is an earlier paper of the current authors (Gatehouse et al [25]) and two detailed prior papers on this technique (Picetti et al [24] and Norton et al [1]). We agree that it may be relevant to the reader to have more detail on the chest wall approach portion of the procedure so have added the following to the Methods section (page 3).

Methods Page 3. “After deflation of a single lung, four portals were made, with the initial most proximal portal being used to assist additional portal placement under direct visualisation using the endoscope. The portals are positioned based on the desired trajectory of the screws which is to be parallel to the vertebral endplates. The portals were made between the ribs through a split made in the intercostal muscles, usually two intercostal spaces apart, allowing access to two or three vertebral levels from a single portal. No ribs are resected or removed during portal placement. If the instrumentation was to extend beyond T12, an interbody spacer cage packed with graft material was placed between T12-L1 after discectomy to assist the spine’s transition into lordosis. Generally L1 can be reached consistently from the thoracic cavity. If the diaphragm inserts above the T12-L1 disc, the diaphragm was partially dissected to allow access from the thoracic cavity. After visualization of lung reinflation, a 20 French Gauge chest drain was inserted through a small additional anterior incision (used for the suction apparatus during the procedure), before closure of the final distal operative portal.”