Author's response to reviews

Title: Unexpected collateral impact after out of hospital resuscitation using LUCAS System

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Answers to Reviewers

Reviewer 1 - Comment 1

Very interesting paper. Congratulations.

Reviewer 1 – Answer 1

We thank the reviewer for the generally positive evaluation of our paper. Please see below for a detailed description of the changes to the manuscript

Reviewer 1 – Comment 2

I will ask only for a minor revision: you are saying that the patient underwent beating heart revascularization. Following that you mentioned that CPB was discontinued. I think that you have to clarify if the patient had on pump CABG, off pump CABG or on pump beating heart CABG.

Reviewer 1 – Answer 2


Changed:
The patient underwent on-pump coronary revascularization with arrested heart using blood cardioplegia.

Reviewer 2 - Comment 1

I did not like the title - patient survived the out of hospital arrest. Resuscitation either by manual or compression devices has recognised risks of sternal or rib injury but is essential and life saving. The injury is not unique to the LUCAS device. Such devices allow doctors or paramedics to perform other duties whilst maintaining compression.

Reviewer 2 - Answer 1

Original title:

`Do consequences justify the means? Severe Bilateral Rib Fractures after Out-of-hospital Resuscitation Using LUCAS System`

Changed

Unexpected collateral impact after out of hospital resuscitation using LUCAS System

Reviewer 2 - Comment 2

It is hard from the manuscript to identify the extent of chest wall injury - CT not done for obvious reasons but clinically was this bilateral flail chest or sternal flail? Needs more description.

Reviewer 2 - Answer 2

Original pg5/line 115-118:

Prior to surgery a seriously flailed chest was noted after reanimation with LUCAS CPR system.

Changed:

Prior to surgery a seriously flailed chest with concomitant left-sided sternal fracture was observed after reanimation with LUCAS CPR system.

Reviewer 2 - Comment 3

If the flail chest was recognized clinically prior to surgery, was fixation not considered at the end of the procedure? The impression of the article is that the fractures were noted on re-inspection
and not initially thought to cause an issue. Traumatic rib fixation is now quite widely established as a treatment if flail chest and ventilated.

Reviewer 2 - Answer 3

Due to patient’s clinical status after reanimation, the initial surgical treatment focused on the coronary revascularization. During chest closure, the patient was hemodynamically instable corresponding to the ECG alterations which was attributed to the flail chest noted preoperatively. Hence, emergent left-sided chest wall stabilization was performed to allow chest closure and to ensure early postsurgical recovery.

The post-surgically performed chest X-ray did not clearly show the further extend of the flail chest, especially the anterolateral area. Hence a CT-scan was performed. This showed extensive bilateral dislocated fractures of the costae 2-6 anteriorly.

Due to further chest instability, prolonged weaning and the risk for pulmonal infection, additional surgical chest stabilization was performed.

Changed lines 143-144; 148-151;

Hence, the hemodynamic instability was attributed to the flail chest noted preoperatively.

The decision was made to perform an emergent chest-wall stabilisation by repositioning the left sided multiple rib fractures prior to closing the chest to enable chest closure; thus, stabilizing the anatomic chest cavity and enabling stable cardiac function

Reviewer 2 - Comment 4

To me the photo suggests fractures of the anterior portions of left 3,4,5 ribs (was this not recognised on harvest of LIMA?) but the x-ray shows fixation 2,5 and 9th? Usually fix adjacent or alternative ribs. Need to explain thought processes? How were the ribs exposed for fixation in the approach?

Reviewer 2 - Answer 4

During LIMA-harvesting the rib fractures on the left side were recognized, however as mentioned in the answer 3, the initial surgery was focused on preventing further cardiac ischemia due to myocardial infarction, hence performing CABG surgery. Further, the fact that the flail chest would cause hemodynamic instability during chest closure was not expected. The emergent chest wall stabilization was performed to enable chest wall closure and enable stable hemodynamic status in order to ensure postsurgical recovery at the ICU.

Changes to the text: addition line 122/123

During LIMA-harvesting the extent of the left-sided rib fractures was noted.
Reviewer 2 - Comment 5

The 2nd rib plate has only 1 screw on one side of the fracture - why? Should be 3. Were the screws not gripping on the costal cartilage anteriorly? In traumatic flail chest 2nd rib fixation is not routinely recommended. Explain your decision to fix?

Reviewer 2 - Answer 5

It is correct, that according to the guidelines for osteosynthesis techniques if possible at least 3 screws should be placed. However, the special circumstances of this case such as emergent chest stabilization procedure as damage control, patient’s supine position, intraoperative assessment of the extend of the flail chest have to be taken into account.

The left-sided rib fractures in combination with left sided double sternal fracture caused the functional anterolateral instability in this case. An osteosynthetic surgical treatment should be considered bilaterally in a case with anterolateral flail chest. Although not every rib fracture has to be fixed. The more dorsal the location for the rib fractures the more the need for a lateral position. In a more complex reconstruction surgery the serratus muscle and/or latissimus dorsi muscle should be mobilized. As a matter of fact, both osteosynthetic-materials can be considered.

In this case, the main purpose was to perform emergent chest wall stabilisation in a less traumatic manner. The fractures were assessed bimanually and repositioned respectively. The dorso-caudal part was fixed via submammary incision after repositioning with a Stratos clamp. Due to its angled tip, a reposition is possible in an acceptable distance to the incision site. Via the same incision, the stabilizing osteosynthesis – system was positioned cranially; this could prevent further dissection and preparation of the intercostal vessels and nerves.

Fixation of the second rib is generally not recommended, especially for the anterolateral parts. However, for the parasternal fixation is this not really an issue. A mini incision was performed over the largest instable area over the pectoralis muscle and after careful dissection, the osteosynthesis- system was positioned. Screw-fixation of the osseous part of the rib enabled absolute stability. Therefore, an additional fixation of the chondral part with the necessity of extending the incision avoided.

Changed lines 151-164:

This was perfomed by placing a Ripfix-Plate (MatrixRIB™ Fixation system, DePuy Synthes) on the 2nd, 5th rib and an osteosynthesis with clip (Stratos™, MedXpert) on the 9th rib (Figure 4a). In addition, the left sided sternal fracture was fixed using a Ripfix-Plate. The procedure was perfomed via an initial submammary incision and further via a mini incision to access the 2nd rib over the pectoralis muscle at the point of the greatest instability. The fixation of the 2nd rib is generally not recommended especially if latero-dorsal instability is present, however this plays a minor role during parasternal instability. Further, we used only one screw during 2nd rib fixation instead of three due to the nature of the procedure as damage control, supine position of the
patient, and limited ability to thoroughly assess the extent of the flail chest intraoperatively. Screw-fixation of the osseous part of the rib enabled absolute stability. Therefore, an additional fixation of the chondral part with the necessity of extending the incision was avoided.

Reviewer 2 - Comment 6

Explain the decision to delay fixation of the right sided rib fractures for 3 days (was it failure to wean off ventilator? Why then favor Statos clips rather than plates?

Reviewer 2 - Answer 6

Post-surgically the patient was hemodynamically stable and could be weaned. However, due to strong pain and paradox breathing during the weaning phase the indication for right-sided chest wall stabilization was given. Moreover, it would reduce the risk for re-intubation.

Both stabilisation systems can be used. The differences are marginal and also the personal experience of the surgeon and preferences were part of the decision to use Stratos clips rather than plates.

Changed lines 167-169:

Post-surgically the patient was hemodynamically stable and was about to be weaned. However, due to strong pain and paradox breathing during the weaning phase the indication for right-sided chest wall stabilization was given.