

# From the costal arch fracture through the intercostal space to the vertebral fracture – Are there injury entities beyond the Sheffield classification?

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## Background

Furthermore, morphologically very similar injuries from internal causes, e.g. from coughing attacks, the so called cough fractures, are described.

From our own collective, we were able to find the traumatic diaphragmatic rupture with intercostal hernia in combination with a vertebral body tear and adjacent rib fractures, i.e. a very severe, life-threatening injury associated with severe violence.

This raises several questions:

Are there injury entities to the costal arch beyond the Sheffield classification?

Can we add to the classification in a meaningful way?

Is it already possible to derive a treatment algorithm?

## Methods

On the basis of 12 consecutively treated patients with rib arch rupture in the past year, the combination injury is presented with regard to its accident mechanism, the spectrum of injuries and the clinical course.

In addition to the Sheffield classification, other associated injuries will be described and then a proposal for a classification system and treatment strategy will be developed

## Results

It is a rather rare combination of injuries (12 out of 180 inpatients) that may be underestimated or overlooked.

For example, 3 of the patients presented only after conservative external treatment, as severe symptoms persisted (2 non-trauma). 4 patients had injuries without trauma.

3 patients had an isolated costal arch rupture, 2 had an additional diaphragmatic rupture, 3 had an additional intercostal hernia, and 4 had a diaphragmatic tear with an intercostal hernia. 6 patients had additional rib fractures lateral or posterolateral, all of which are in direct contact with the injured intercostal space. The 7th-9th intercostal space (n=8 on the left side) were affected. In the case of isolated rib arch tears and only additional diaphragmatic injury, no other adjacent rib fractures were observed.

Isolated rib arch tears can be treated conservatively if they heal stably on follow-up.

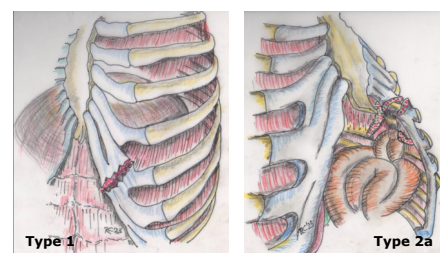
If additional injuries occur, surgical treatment should be performed. It is possible to progress the condition pictures over the subtypes shown here with escalation of the injury severity up to type 3. Type 4 represents a serious injury entity.

Rib fractures are reduced and treated by osteosynthesis (SSRF), diaphragmatic avulsions are refixed transcostally. The costal arch is sutured and ideally additionally fixed with plates and screws, the intercostal space is sutured in the case of recent injuries and augmented with mesh in the case of chronic injuries and spontaneous tearing according to the Sheffield experience.

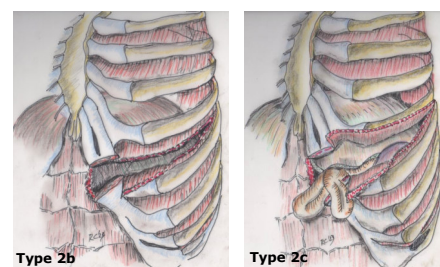
## Conclusion

Thus, there are the following injury entities from the small collective and a resulting classification possibility:

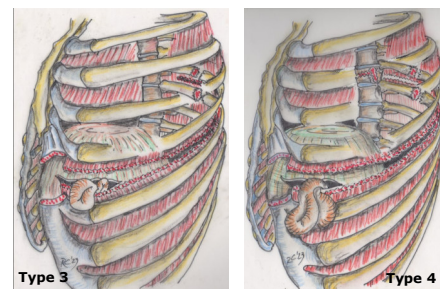
(see diagram and figures below)



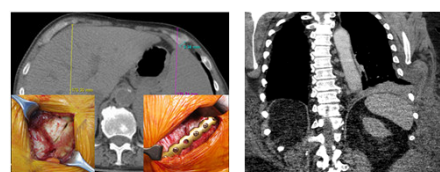
Type 1 Isolated costal arch tear  
Type 2a + additional diaphragmatic rupture



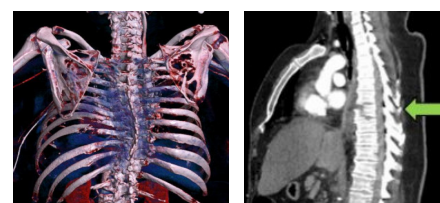
Type 2b + additional intercostal hernia  
Type 2c + both of them (traumatic diaphragmatic rupture and intercostal hernia)



Type 3 + additional rib fractures along the intercostal injury  
Type 4 + additional vertebral disruption next to the Intercostal space  
(All figures by Prof. Roman T. Carbon, Erlangen with courtesy)



Type 1 Type 2c



Type 3 Type 4

