Investigation of myocardial contusion with sternal fracture in the emergency department

Multicentre review

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Abstract

Objective To describe the use of initial electrocardiogram (ECG), follow-up ECG or equivalent monitoring, and troponin I in patients presenting with sternal fracture who are assessed in emergency departments or by front-line physicians.

Design Multicentre descriptive retrospective study.

Setting Two traumatology teaching centres in Quebec city, Que.

Participants Fifty-four trauma patients presenting with sternal fracture.

Interventions Assessment of the use of initial ECG, ECG or equivalent monitoring 6 hours after trauma, and troponin administration.

Main outcome measures In terms of ECG use, quality comparison criteria were selected on the basis of expert opinions in 4 studies. An initial ECG and a follow-up ECG 6 hours after trauma or cardiac monitoring 6 hours after trauma were recommended by most authors for diagnosing myocardial contusion in cases of sternal fracture. Serum troponin I administered 4 to 8 hours after chest trauma was also recommended by some as an effective means of detecting substantial arrhythmia secondary to myocardial contusion. Descriptive univariate analyses and χ^2 tests were performed. A $P<.05$ was considered significant.

Results Thirty-nine patients (72%) were assessed initially with ECGs; after 6 hours in the emergency department, 18 of these patients (33%) had follow-up ECGs or equivalent cardiac monitoring. Sixteen patients (30%) were assessed by means of troponin I dosage. Two patients (4%) presented with ECG abnormalities and only 1 patient (2%) presented with an elevated troponin I level.

Conclusion Emergency physicians must increase their use of ECG in initial or follow-up diagnosis for trauma patients presenting with sternal fracture to detect myocardial contusion and arrhythmia. The use of troponin in conjunction with ECG is also suggested for this population in order to identify patients at risk of complications secondary to myocardial contusion.

EDITOR'S KEY POINTS

- Formerly considered an indicator of severe trauma requiring admission, sternal fracture is now most often a benign condition that can be treated on an outpatient basis.
- Cardiac complications in trauma patients with sternal fracture are difficult to predict.
- The results of this study indicate that the use of electrocardiograms (ECGs) to diagnose arrhythmia in patients presenting to the emergency department with sternal fracture does not correspond to the current recommendations.
- The recommendation for the use of an initial ECG and a follow-up ECG or equivalent monitoring 6 hours after trauma in this population needs to be reiterated.

This article has been peer reviewed.
Can Fam Physician 2014;60:e126-30

Sternal fracture is rarely seen in the emergency department.[1,2] With the advent, a number of years ago, of compulsory seat belt use by motor vehicle occupants, physicians' attitudes toward sternal fracture have changed.[3] At one time, sternal fracture was considered an indicator of trauma requiring admission; now, sternal fracture is often a benign condition that can be treated on an outpatient basis.[4] Myocardial contusion and arrhythmia remain substantial complications found in 8% to 10% of cases.[1,2,5,6]

It is difficult to predict which trauma patients will present with cardiac complications following sternal fracture. In a cohort of 272 patients, Brookes et al found that the risk factors for arrythmia following sternal fracture were age equal to or greater than 65 years and the presence of atherosclerotic cardiovascular disease (ASVD).[7]

Several authors report that the use of initial ECG and follow-up ECG or cardiac monitoring 6 hours after trauma makes it possible to detect clinically substantial myocardial contusion.[8-11] Several authors also propose troponin I administration within 4 to 8 hours after trauma to detect this condition.[12-16] This method has good specificity (60% to 100%), but quite variable sensitivity from one study to the next (23% to 100%) for predicting substantial myocardial damage (such as arrythmia, hypotension, or shock) in patients who have experienced chest trauma.[12-15] As a result, its use remains controversial. A combination of the 2 modalities, ie, troponin I and ECG, has been reported in a number of studies, making it possible to calculate a sensitivity of 100% and a specificity of 45% to 89% for a combination of these 2 tests.[13-15]

The purpose of this study is to describe the use of initial ECG, follow-up ECG (or equivalent monitoring), and troponin I administration in patients presenting with sternal fracture who are assessed in the emergency department.

METHODS

Population and design

This multicentre descriptive retrospective study of the practices of emergency physicians was conducted in 2 traumatology teaching centres in Quebec city, Que: Hôtel-Dieu de Lévis and Hôpital de l'Enfant-Jésus. The medical records to be reviewed were identified using the clinics' administrative software program. The criterion for selection was diagnosis of sternal fracture (*Classification statistique internationale des maladies et des problèmes de santé connexes, 10e révision,* codes S22.200 and S22.201) for the period from January 1, 2007 to October 1, 2010. Records were retained for analysis if the patient was initially assessed in the emergency department and if a sternal fracture was suspected by the emergency physician based on the initial x-ray scan.

The records were reviewed using a standardized assessment template used to collect epidemiologic data from the population. The following variables were compiled: sociodemographic data; history of ASVD; initial ECG; follow-up ECG 6 or more hours after trauma; cardiac monitoring 6 hours after trauma; serum troponin dosage within the first 8 hours; sternal x-ray scan; lung x-ray scan; thoracic computed tomography (CT) scan; and cardiac ultrasound scan.

Main outcome measures

In terms of ECG use, quality comparison criteria were selected on the basis of expert opinions in 4 studies.[8-11] An initial ECG and a follow-up ECG 6 hours after trauma or cardiac monitoring 6 hours after trauma were recommended by most of these authors for diagnosing myocardial contusion in cases of sternal fracture. Serum troponin I administered 4 to 8 hours after chest trauma was also recommended by some authors as an effective way of detecting substantial arrhythmia secondary to myocardial contusion.[12-16] Descriptive univariate analyses and χ^2 tests were performed. A $P<.05$ was considered significant.

RESULTS

Fifty-four records were identified. The characteristics of the study subjects are presented in **Table 1**. The mean (SD) age of the patients included in the study was 51 (21) years; 13% of the patients presented with ASVD and 54% were women. In 83% of patients the trauma resulted from a motor vehicle accident. Fifty-four sternal fractures were suspected by the emergency physicians; 38 (70%) were confirmed by the radiologists.

Table 1. Characteristics of 54 patients suspected by emergency or front-line physicians of having sternal fractures

CHARACTERISTIC	VALUE
Mean (SD) age, y	51 (21)
Sex, n (%)	
• Male	25 (46)
• Female	29 (54)
ASVD, n (%)	7 (13)
Type of trauma, n (%)	
• Vehicle	45 (83)
• Direct	6 (11)
• Other	3 (6)

ASVD—atherosclerotic vascular disease.

In total, 72% of patients presenting with traumatic sternal fracture in the emergency department were initially assessed with ECGs; 33% of these patients were assessed by means of ECG or cardiac monitoring 6 hours after trauma. Close to one-third (30%) of patients were assessed using troponin dosage.

Table 2 and **Figure 1** show the distribution of patients who had initial ECGs and follow-up ECGs or monitoring, as well as those who had troponin dosage, based on the predetermined subgroups.

Table 3 shows the use of sternal and pulmonary x-ray scans, thoracic CT scans, and cardiac ultrasound scans.

Cases and complications

In this cohort of patients, 2 complex cases required extended observation and additional investigation.

In the first case, an 87-year-old woman with a history of myocardial infarction sustained an isolated sternal fracture as a passenger in a motor vehicle accident. During observation, she presented with bradycardia descending to 40 beats per minute, associated with first-degree atrioventricular blockage. This abnormality disappeared after 24 hours and no further events were noted. Her troponin dosage was below the detection threshold. A cardiac ultrasound scan was not performed. A diagnosis of myocardial contusion was made.

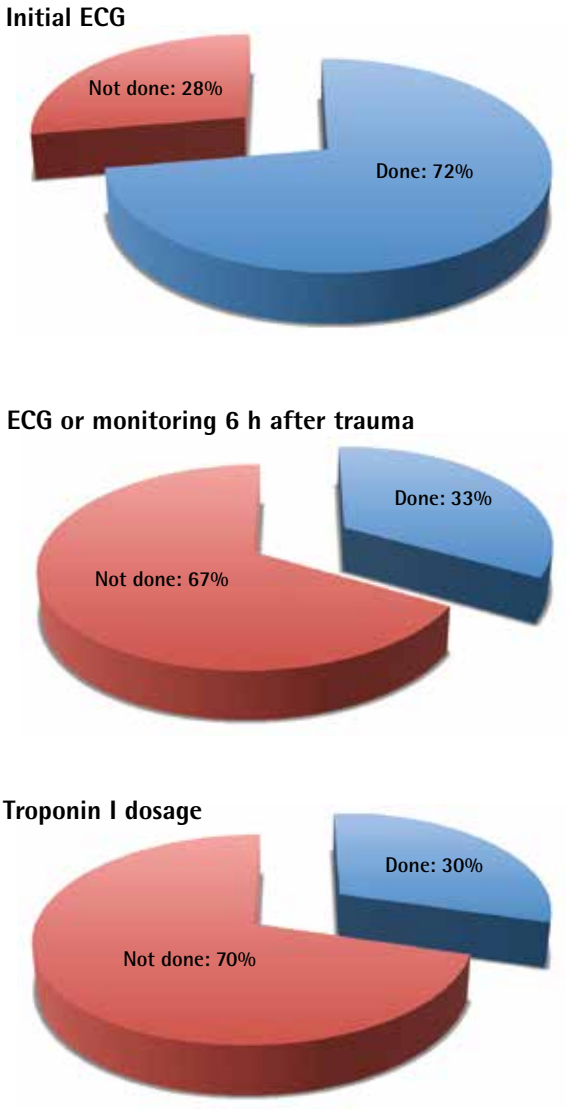
In the second case, a 78-year-old woman with no known history of ASVD had a de novo left bundle branch block on initial ECG. She had sustained an isolated sternal fracture as the driver of a motor vehicle involved in an accident. She did not report syncope. Her

Table 2. Use of initial ECG, ECG or equivalent monitoring 6 h after trauma, and troponin I dosage in patients suspected by emergency or front-line physicians of having sternal fractures based on their risk factors and provenance

INVESTIGATION	USE, N (%)
Initial ECG	
• Total (n = 54)	39 (72)
• ASVD (n = 7)	6 (86)
• Age ≥ 65 y (n = 15)	12 (80)
• HEJ (n = 40)	27 (68)
• HDL (n = 14)	12 (86)
ECG or monitoring 6 h after trauma	
• Total (n = 54)	18 (33)
• ASVD (n = 7)	2 (29)
• Age ≥ 65 y (n = 15)	7 (47)
• HEJ (n = 40)	12 (30)
• HDL (n = 14)	6 (43)
Troponin I dosage	
• Total (n = 54)	16 (30)
• ASVD (n = 7)	5 (71)*
• Age ≥ 65 y (n = 15)	5 (33)
• HEJ (n = 40)	13 (33)
• HDL (n = 14)	3 (21)
• Positive test results for myocardial contusion	1 (6)

ASVD—atherosclerotic vascular disease, ECG—electrocardiogram, HDL—Hôtel-Dieu de Lévis, HEJ—Hôpital de l'Enfant-Jésus.
*$\chi^2 = 5.78$; $P = .02$.

Figure 1. Use of initial ECG, ECG or equivalent monitoring 6 h after trauma, and troponin I dosage for patients suspected by emergency or front-line physicians of having sternal fractures



ECG—electrocardiogram.

Table 3. Diagnostic tools used in patients suspected by emergency or front-line physicians of having sternal fractures

DIAGNOSTIC TOOL	PRESCRIBED, N (%)	POSITIVE RESULTS FOR MYOCARDIAL CONTUSION ACCORDING TO SPECIALIST,* N (%)
X-ray scan of sternum	54 (100)†	38 (70)
X-ray scan of lung	49 (91)	9 (18)‡
Computed tomography scan of thorax	5 (9)	5 (100)
Cardiac ultrasound scan	4 (7)	0 (0)

*Interpretation by cardiologists for cardiac ultrasound scans and by radiologists for other tests.
†16 sternal x-ray scans (30%) of patients suspected by emergency or front-line physicians of having sternal fractures were interpreted as having negative results for myocardial contusion by the radiologist.
‡Results: 3 cases of mediastinal hematoma, 3 cases of multiple rib fracture, 1 fracture of the sixth dorsal vertebra, 1 case of pulmonary contusion, and 1 case of sternoclavicular dislocation.

troponin I dosage, administered 8 hours after trauma, was above the positivity threshold. She was kept under observation; a cardiac ultrasound scan revealed only those abnormalities usually associated with left bundle branch block. A diagnosis of myocardial contusion was made by a cardiologist. No other complications were noted during observation.

DISCUSSION

In light of the results we obtained, the use of ECG to diagnose arrhythmia in patients presenting to the emergency department with sternal fracture does not correspond to the current recommendations.

Only 72% of the patients in our study underwent initial ECGs. This is surprising, considering the low cost of this examination, the fact that it is widely available in emergency departments, and the relatively high proportion of arrhythmia in this population.[1,2,5,6] In addition, only 33% of patients underwent follow-up ECGs or monitoring 6 hours after trauma.

The χ^2 test did not demonstrate a significant association ($P<.05$) between the subgroups in the study and the application of the recommendations for ECG use. However, a substantially larger proportion of initial ECG use was observed in the ASVD group (86%) and the 65 years and older group (80%), compared with the general population studied (72%). For the 65 years and older group, we observed more extensive use of ECG and follow-up monitoring than in the general population (47% vs 33%); this was not true in the ASVD group (29%). These findings are surprising when we consider that Brookes et al identified these characteristics as factors that would predispose a patient to arrhythmia secondary to sternal fracture.[7] Thus, the application of the recommendations remains very weak, particularly for these at-risk groups.

Serum troponin I dosage 4 to 8 hours after trauma was used in 30% of cases of suspected sternal fracture. A χ^2 test demonstrated a significant association between the use of troponin and the ASVD subgroup (71%; $P=.02$). This association could be influenced by an increased suspicion of complications of myocardial contusion in this subgroup on the part of clinicians. Only 1 test result was positive for myocardial contusion (6% of the tests) and it was associated with 1 of the 2 cases of myocardial contusion identified on ECGs. This result appears to corroborate the correct specificity of troponin dosage (60% to 100%) for myocardial contusion.[12-15]

However, the sensitivity of this test for this condition remains unclear (23% to 100%).[12-15] As a result, this test should not be used alone to screen for clinically substantial myocardial contusion. Furthermore, troponin dosage test results were only positive in 1 of the 2 patients who presented with myocardial contusion identified with abnormal ECGs. However, the combination of ECG and troponin I dosage 4 to 8 hours after chest trauma demonstrated a sensitivity of 100% in 3 studies,[13-15] while maintaining a reasonable specificity (45% to 89%) for screening for substantial myocardial contusion following chest trauma. This combination of screening tests could be a relevant strategy for identifying patients who are at risk of developing substantial complications (arrhythmia, hypotension, and shock) and who should be observed over some time.

The level of agreement over the presence of sternal fracture on the x-ray scans between the front-line physicians and the radiologists in our cohort was 70%. The sensitivity of sternal x-ray scans interpreted by radiologists is 70% compared with CT.[17,18] Although CT is the criterion standard test,[17,18] it requires a much higher dose of radiation.[19] You et al suggest the use of ultrasound in the emergency department as a less invasive and less costly method of diagnosing sternal fracture.[18] To limit exposure to radiation for isolated minor trauma, a combination of x-ray and ultrasound scans could be considered.

Limitations

This retrospective study was conducted in 2 teaching hospitals in Quebec city, a city of average size with a largely white, French-speaking population. Any application of these findings to the diagnosis and treatment of

sternal fracture in other patient populations must take this into account. Nevertheless, our recommendations remain valid. The limited number of patients with sternal fracture was to be expected; this is a rare pathology. Therefore, the statistical tests are limited.

In their prospective study on minor chest trauma, Misthos et al demonstrated that hemothorax (7.4%) or pneumothorax (2%) could appear up to 14 days after trauma.[20] It was not possible in our retrospective study to determine whether the study population experienced delayed complications or what the evolution of the patients who experienced myocardial contusion was. A prospective study on a cohort of patients who had experienced sternal fracture would therefore be relevant.

The differential diagnosis in both cases of myocardial contusion included acute coronary syndrome and the presence of malignant arrhythmia before the trauma.[21] However, our review of the medical records indicated that the medical team made a diagnosis of myocardial contusion, which could potentially represent a classification bias.

Conclusion

It appears that emergency physicians underused ECG to diagnose arrhythmia and myocardial contusion in these patients, both initially and on follow-up. Consequently, the recommendation of initial ECG and ECG 6 hours after trauma or equivalent cardiac monitoring for this population needs to be reiterated. Although there is no consensus in the literature on serum troponin I dosage as a diagnostic tool for sternal fracture, this test was of use for identifying patients at risk of arrhythmia in our sample. While being mindful of their limitations, we therefore suggest their concomitant use for diagnosing clinically substantial myocardial contusion, which should be observed over a period of some time.

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Contributors

Dr Audette contributed to review of the literature, data collection and analysis, and preparation and revision of the article. **Dr Émond** contributed to data collection and analysis, revision of the article, article formatting, study design, and ideas. **Dr Scott** provided help with data collection, revision of the article, study design, and ideas. **Dr Lortie** provided help with data collection, revision of the article, study design, and ideas.

Competing interests

None declared

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