One-year follow-up of the 2011 Christchurch Earthquake stress cardiomyopathy cases

Christina Chan, Richard Troughton, John Elliott, Julie Zarifeh, Paul Bridgman

Abstract

Introduction A major earthquake struck Christchurch on 22 February 2011 causing extensive damage to the city and 185 direct fatalities. Within 4 days 21 postmenopausal women presented to Christchurch Hospital with stress cardiomyopathy. We were able to closely examine these patients in the immediate phase of presentation and at 12 months.

Methods Patients were prospectively identified. Clinical details at presentation were recorded including basic characteristics, symptoms, investigations, results, treatments and complications. At 12 months, telephone interviews were conducted. Patients answered a structured questionnaire to assess their cardiac and general health concerns. Consenting patients also received three psychometric questionnaires to assess psychological wellbeing.

Results The majority of patients had classic features of stress cardiomyopathy. Recovery was prompt with low complication rate. At 12 months, survival rate was 100%. Five patients had hospital readmissions early on—three of which were cardiac related. None had ongoing symptoms or stress cardiomyopathy recurrence. Seven patients had non-cardiac related medical problems. The psychometric questionnaires showed that none had a high level of health anxiety, general anxiety or depression. Four patients endorsed symptoms suggestive of borderline post-traumatic stress disorder.

Conclusion The Christchurch Earthquake stress cardiomyopathy cohort has had good short-term and medium-term outcomes without significant cardiac or psychological sequelae.

Stress cardiomyopathy (SCM) is a fascinating condition that is triggered by emotional stress and may mimic acute myocardial infarction in presentation. Over the past decade, there has been an increase in frequency of publications on SCM as it has gained broad attention in the field of cardiology around the world. However, given the rarity of SCM, the majority of the publications are individual case reports or small case series.

Most of the case series in the literature list individuals with SCM triggered by a wide range of poorly characterised stressors occurring over a period of time. The exception was the work done by Watanabe’s group, presenting 25 patients with SCM triggered by a single stressor, the 2004 Niigata earthquake. However, their study lacked in detailed information such as patient characteristics or clinical outcomes.

On 22 February 2011, Christchurch, the second largest city in New Zealand with an urban population of 400,000, was struck by a 6.3 magnitude earthquake at 12:51pm.
The city suffered great damage and 185 lives were lost. As expected, cardiovascular complications increased.\(^3\)

Within 4 days of the event, 21 patients presented to Christchurch Hospital with SCM.\(^4\) This was an exceptionally high number given that annually, approximately six patients would be diagnosed with this condition only. After the September 2010 earthquake, nine patients presented with SCM within 1 week.

As Christchurch Hospital was the region’s only acute cardiac service provider, an opportunity arose to further study these 21 SCM patients. The aim was to provide a better understanding of this unique condition, not only in the acute phase, but also in the intermediate period, especially when patients were exposed to similar stressors (aftershocks) after their initial presentations.

A follow-up study at 12 months after the February 2011 earthquake was therefore launched.

**Method**

The 21 patients with earthquake induced SCM were prospectively identified by Cardiology Department staff in the days following the earthquake. Systematic review of the clinical files, electronic discharge summaries, coronary angiograms and echocardiograms were undertaken for each patient. Data collected included basic patient characteristics, date of admission and discharge, investigations performed and results.

The diagnosis of stress cardiomyopathy was defined similar to the modified Mayo criteria.\(^5\) All patients were admitted with chest pain and evolving ECG changes, a troponin I rise $>0.03\text{mcg/l}$, a recognised transient echocardiographic regional wall motion abnormality (apical ballooning pattern, mid wall variant or basal segment variant), and no culprit lesion on coronary angiography. Once the SCM patients were identified, a record of their clinic follow-up, medications and hospital readmissions were kept.

In March 2012, telephone interviews were conducted by an investigator. A structured questionnaire was used to assess patients’ self-reported cardiac and general health status. Patients answered questions enquiring about their cardiac symptoms, especially in relation to major aftershocks, hospital admissions, other non-cardiac medical conditions and treatment.

After the initial telephone interview, three validated psychometric questionnaires were also posted out for consenting patients to complete. The Health and Anxiety Questionnaire (HAQ), the Hospital Anxiety and Depression Scale (HADS) and the Impact of Event Scale-Revised (IES-R) were used to assess the psychological well-being of this cohort of patients.

The HAQ was developed to identify individuals with high levels of concern about their health.\(^6\) Total scores of 0–8 have been classified as representing low, 9–13 as medium, and 14 and above as high health anxiety.\(^7\) The HADS has been shown to accurately diagnose generalized anxiety disorders and major depressive episodes in an outpatient setting.\(^8\) Anxiety disorders and depression are defined by the use of a score $\geq 8$ as cut-off.

The IES-R was developed to reflect the Diagnostic and Statistical Manual of Mental Disorders IV (DSM IV) criteria of post-traumatic stress disorder (PTSD) in 1997.\(^9\) It aims to assess levels of intrusion, avoidance and hyperarousal. Patients who score $\geq 33$ may have post-traumatic stress disorder.

**Results**

All 21 SCM patients were postmenopausal females with median age of 68 years (52–85 years). As a whole, the group had few conventional cardiovascular risk factors (Table 1). One patient had a history of ischaemic heart disease requiring stenting to right coronary artery and left circumflex artery in September 2010. She actually presented shortly after the September 2010 earthquake with the typical apical balloon
pattern of SCM. Her left ventricular regional wall motion abnormality on echocardiography study extended beyond the area supplied by her diseased coronary arteries. Another woman also had a history of SCM. She had previously presented in August 2009 with apical ballooning triggered by an emotional stressor.

Table 1. Basic patient characteristics of the 21 SCM patients

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total cases=21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>68 years, median (52–85 years, range)</td>
</tr>
<tr>
<td>Females</td>
<td>21 (100%)</td>
</tr>
<tr>
<td>NZ European</td>
<td>20 (95.2%)</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>1 (4.8%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>5 (23.8%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>8 (38%)</td>
</tr>
<tr>
<td>Atrial fibrillation / atrial flutter</td>
<td>2 (9.5%)</td>
</tr>
<tr>
<td>CVA / TIA</td>
<td>1 (4.8%)</td>
</tr>
<tr>
<td>Current or ex smoker</td>
<td>5 (23.8%)</td>
</tr>
<tr>
<td>Previous SCM</td>
<td>2 (9.5%)</td>
</tr>
<tr>
<td>Psychiatric illness</td>
<td>2 (9.5%)</td>
</tr>
</tbody>
</table>

All patients had chest pain on admission. The median troponin I level was 1.6 mcg/l (IQR 1.2–5.5 mcg/l). Everyone had ECG changes including ST elevation (12 patients), ST depression (two patients) and deep T wave inversion (seven patients). Median QTc interval prolongation was prolonged at discharge (493ms IQR 375ms to 560ms) compared to QTc on admission (437ms IQR 360ms to 480ms).

All patients had echocardiography studies within 24 hours of initial presentation. The typical pattern of mid wall and apical hypokinesis or akinesis was documented in 19 patients. The other two women had the mid wall variant of SCM with sparing of the apex. The median left ventricular ejection fraction was 39% (IQR 30–45%).

The patient who presented with the typical apical ballooning form of SCM after the September earthquake had a different regional wall motion abnormality on this occasion. She had the mid wall variant of SCM.\(^{10}\)

Coronary angiography was performed in 20 women. The patient with previous history of SCM in August 2009 had a completely normal study then, therefore it was not repeated. Only one patient had severe circumflex disease that required treatment. Her left ventricular regional wall motion abnormality extended beyond the diseased single coronary vascular bed and involved the whole of apex and mid wall region. The rest of the group had either normal coronary arteries (nine patients), mild atheroma only (nine patients) or patent stents with no new lesions (one patient).

The average length of hospital admission was 37 hours (IQR 7–51 hours). Two patients developed mild left ventricular failure and were successfully managed with oral frusemide treatment. None required inotropic support or intra-aortic balloon pump insertion. There were no deaths in this SCM group during the study period.

The follow-up rate post discharge was good with 19 patients attending Cardiology Outpatient Clinic review. The median time to clinic follow-up was 56 days (IQR 54–
Echocardiography studies were repeated a few days prior to or on the day of the clinic appointments. All 19 patients had normal left ventricular systolic function with a median left ventricular ejection fraction of 67% (IQR 64–72%). Only two patients had residual mild apical hypokinesis whereas 17 had no left ventricular regional wall motion abnormality.

At 12 months, all 21 SCM patients were successfully interviewed. Two patients left Christchurch shortly after the 2011 earthquake. One had taken permanent residence in the North Island and the other had returned to live in Christchurch 13 months after the event. The remaining 19 patients stayed in Christchurch.

Initially, six women still had chest pain after discharge. Five patients reported that they have experienced a few episodes of chest pain with aftershocks. One patient experienced chest pain on exertion. She had normal coronary arteries on coronary angiography in February. All reported their symptoms settled by May 2012. There was no recurrence of SCM in the 12 months follow-up period.

There were a total of six hospital admissions—five patients were admitted to hospital and one patient had two admissions in the follow-up period. There were three cardiac related admissions in March 2011. One patient re-presented 1 day after discharge with heart failure symptoms. She stayed in hospital for another 24 hours and received treatment for heart failure.

A patient presented 9 days after she was discharged with chest pain. She did not have new ECG changes or significant troponin rise and was managed conservatively. Another patient presented 28 days after initial discharge with atrial fibrillation requiring rate control treatment. There were three non-cardiac related admissions that occurred later on which included exacerbation of chronic airway disease, pain due to compression fractures and renal colic.

Seven out of 21 patients reported ongoing active medical problems. Musculoskeletal disorder was the commonest concern with five patients suffering from conditions such as compression fracture, fracture of wrist, osteoporosis, sciatica, rheumatoid arthritis and osteoarthritis. A patient was diagnosed with hyperthyroidism and borderline type 2 diabetes mellitus. Another patient suffered from chronic obstructive airway disease. The majority of patients remained healthy with no ongoing medical issues.

Prior to developing SCM, not many patients were on cardiovascular related medications (Table 2). Most patients were treated with aspirin and beta blockers during and after their admission with 43% receiving angiotensin-converting-enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB).

At follow-up clinic appointments most patients had the beta blockers discontinued. Our 12-month follow-up interview found that beta blockers and ACEI/ARB were restarted in a number of cases; the patients reported that hypertension was the most common reason for this.
Table 2. Medication changes for the 21 SCM patients

<table>
<thead>
<tr>
<th>Medication</th>
<th>Prior to SCM N=21</th>
<th>During admission N=21</th>
<th>Post clinic follow-up N=19</th>
<th>At 12 months N=21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>7 (33.3%)</td>
<td>16 (76.2%)</td>
<td>7 (36.8%)</td>
<td>7 (33.3%)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>1 (4.8%)</td>
<td>2 (9.5%)</td>
<td>1 (5.3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Beta-blocker</td>
<td>3 (14.2%)</td>
<td>19 (90.5%)</td>
<td>6 (31.6%)</td>
<td>10 (47.6%)</td>
</tr>
<tr>
<td>ACEI/ARB</td>
<td>4 (19%)</td>
<td>9 (42.9%)</td>
<td>6 (31.6%)</td>
<td>9 (42.9%)</td>
</tr>
<tr>
<td>Statin</td>
<td>6 (28.6%)</td>
<td>7 (33.3%)</td>
<td>6 (31.6%)</td>
<td>6 (28.6%)</td>
</tr>
<tr>
<td>Long-acting nitrate</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (5.3%)</td>
<td>1 (4.8%)</td>
</tr>
<tr>
<td>Calcium channel blocker</td>
<td>1 (4.8%)</td>
<td>1 (4.8%)</td>
<td>1 (5.3%)</td>
<td>3 (14.3%)</td>
</tr>
<tr>
<td>Anxiolytics</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Seventeen patients completed the HAQ. Overall, 9 patients had normal health anxiety levels (score 0 to 8) and 8 patients had a medium level of health anxiety (score 9 to 13). No one had a high level of health anxiety according to the questionnaire.

Eighteen patients completed the HADS. The test indicated that only 5 patients had borderline anxiety (score 9 to 13) and 1 had borderline depression (score 10). The rest of the group did not have an abnormal level of anxiety or depression. Sixteen patients completed the IES-R questionnaires. Twelve patients were thought not to have PTSD as they had a normal score (score 2 to 26). Four patients might have borderline PTSD as they had a score greater than 33 (score 39 to 45).

**Discussion**

This earthquake study provides detailed initial and follow-up data on 21 cases of SCM triggered by the February 2011 Christchurch earthquake. It is a unique case series, in that all cases had the same single emotional stressor.

The clinical features of the 21 SCM at initial presentations detailed in this study were very similar to previous case series. This includes chest pain on presentation, ECG changes of ST elevation followed by T wave inversion and QTc prolongation, modest elevation of myocardial injury markers, transient and reversible apical ballooning on echocardiography, and the lack of significant coronary disease on angiography. The time course of disease recovery was also in accordance with literature.

Most patients had complete normalisation of left ventricular function and regional wall motion within a few weeks. Our data shows that the patients could do well with a very short hospital admission. The Cardiology Department staff had previous experience of managing a cluster of SCM following the September 2010 earthquake. This led to a high index of suspicion and rapid investigation and treatment.

In the days following the earthquake the hospital was under significant strain and there was pressure to discharge patients as soon as they were safe to leave. Patients who were stratified by their clinicians to be low risk had very short hospital stays, as short as 3 hours.

At 12 months, a telephone interview showed 100% survival rate with no ongoing cardiac sequelae. One-third of the patients suffered from medical issues such as musculoskeletal problems, chronic airway disease, hyperthyroidism and renal colic.
This was not unexpected given the median age of this cohort of patient was 72 years. At 12 months, there was no SCM recurrence. The rate of recurrence was low compared to previous case series.\(^{17}\)

The favourable 12 month outcome data of this cohort of patients was comparable to Parodi’s findings at 6 months.\(^{18}\) This was in contrast to Sharkey’s findings with 15% of mortality rate from four months to 4.7 years from SCM onset.\(^{14}\) Obviously, a longer study period for our cohort of SCM would be ideal to further assess prognosis of this condition, but it is notable how good the cardiovascular outcomes were for the period we studied.

In terms of psychological outcomes, psychometric questionnaires showed that none had a high level of health anxiety level and the majority was not depressed or anxious. Only four patients had possible borderline PTSD. The three psychometric questionnaires showed that the majority of the SCM patients were not particularly anxious or depressed nor did they have PTSD at 12 months after the February 2011 earthquake.

The strength of this study is that this is a single centre experience. Given that Christchurch Hospital was the only acute hospital in the region and that the 21 patients with SCM were all residents of the city, we had complete capture of data. This also ensured good follow-up attendance which was of utmost importance to monitor recovery.

The weakness of this study is the lack of a matched control group and baseline psychometric testing on our study group. Ideally, they should all have similar tests during hospital admission immediately post event to establish baseline levels of health anxiety, generalised anxiety, depression and tendency for PTSD. Given their SCM were triggered by a clear emotional stressor, it would be easy to assume that this group of women were more emotionally vulnerable.

However, a study done after the September 2010 earthquake, Zarifeh et al successfully obtained complete psychometric data from six SCM patients as well as from five patients with AMI and six with non-cardiac chest pain presentations.\(^{16}\) Within 6 weeks of the earthquake, these women underwent a semi-structured interview with a senior clinical psychologist who was blinded to the patients’ cardiac diagnosis. They found that SCM following an earthquake was not specific to psychologically vulnerable women.

In fact, women who presented with non-cardiac chest pain following an earthquake had higher anxiety and neuroticism scores than women with either AMI or SCM. There was no excess of depression or depressive symptoms in any of the three groups. The medium-term data from the February 2011 earthquake adds to a picture of SCM occurring in otherwise psychologically robust women and carrying no medium-term psychological risk.

**Conclusion**

The 22 February 2011 earthquake triggered 21 cases of SCM within 4 days of the event. All 21 patients were postmenopausal women with few cardiovascular risk factors. The short-term clinical outcome was excellent, with no mortality or significant morbidities.
The follow-up study was launched at 12 months in order to gain better understanding of longer-term outcome of earthquake induced SCM patients, as it has not been previously studied. Again, patient outcome was favourable with 100% survival without SCM recurrence. Most patients remained healthy both physically and psychologically despite being exposed to incessant aftershocks following February 2011.

**Competing interests:** Nil.

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**References:**


