Head and Neck Pain in Patients Presenting with Acute Aortic Dissection

Stephen Philip, MD, MS1 Emil Missov, MD, PhD2 Dan Gilon, MD3 Stuart Hutchison, MD4 Ali Khoynazhd, MD, PhD5 Arturo Evangelista, MD6 Mark Bonaca, MD, MPH7 Lori Conklin, MD8 Jehangir Appoo, MD4 Marco Di Eusanio, MD, PhD9 Alan Braverman, MD10 Alberto Forteza, MD11 Daniel Montgomery, MS1 Christoph Nienaber, MD, PhD12 Eric Isselbacher, MD13 Kim Eagle, MD1

1Department of Internal Medicine, University of Michigan Health System, Ann Arbor, Michigan  
2Department of Internal Medicine, University of Minnesota Physicians Heart Practice, Minneapolis, Minnesota  
3Department of Non-invasive Cardiology, Hadassah Hebrew University Medical Center, Jerusalem, Israel  
4Libin Cardiovascular Institute, University of Calgary Medical Centre, Calgary, Canada  
5Department of Cardiovascular Surgery, Long Beach Medical Center, Los Angeles, California  
6Department of Cardiology, Hospital General Universitari Vall D’hebron, Barcelona, Spain  
7Department of Cardiovascular Medicine, Brigham & Women’s Hospital, Boston, Massachusetts  
8Department of Anesthesiology, University of Virginia Health System, Charlottesville, Virginia

Address for correspondence Stephen Philip, MD, MS, Department of Internal Medicine, University of Michigan Health System, 24 Frank Lloyd Wright Drive, Lobby A/3201, Ann Arbor, MI 48106 (e-mail: Stephen.philip@phhs.org).

9Department of Cardiovascular Surgery, Ospedali Riuniti Ancona, Ancona, Italy  
10Department of Cardiology, Washington University, School of Medicine, St. Louis, Missouri  
11Department of Cardiac Surgery, Hospital Universitario Puerta De Hierro, Madrid, Spain  
12Cardiology and Aortic Centre, The Royal Brompton & Harefield Nhs Trust, London, United Kingdom  
13Thoracic Aortic Center, Massachusetts General Hospital, Boston, Massachusetts

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Abstract

Background  Head and neck pain is an atypical presentation of acute aortic dissection. Classic teaching associates this pain with proximal dissections, but this has not been extensively studied.

Methods  Patients enrolled in the International Registry of Acute Aortic Dissection from January 1996 to March 2015 were included in this study. We analyzed the demographics, presentation, treatment, and outcomes of Type A aortic dissection patients presenting with head and neck pain (n = 812, 25.8%) and compared it with those without these symptoms (n = 2,341, 74.2%).

Results  Patients with head and neck pain were more likely to be white, female, with a family history of aortic disease. Patients with head and neck pain had higher percentages of back pain (43.3% vs. 37.5%, p = 0.005) and chest pain (87.6% vs. 79.3%, p < 0.001). On imaging, a higher percentage of those with head and neck pain had arch vessel involvement (44.3% vs. 38%, p = 0.010) and intramural hematoma (11.7% vs. 8.1%, p = 0.003). Surgical management was more common in patients with head and neck pain (89.8% vs. 85.2%, p = 0.001). Regarding outcomes, patients with head and neck pain had significantly higher rates of stroke than those without head and neck pain (13% vs. 9.9%, p = 0.016); however, overall mortality was lower for those with head and neck pain (19.5% vs. 23%, p = 0.038).

Keywords  ► Head Pain  
► neck pain  
► aortic dissection
Those with head and neck pain only had higher overall mortality compared to those with head and neck pain with chest or back pain (34.6% vs. 19.9%, \( p = 0.013 \)). A logistic regression of mortality revealed that preoperative hypotension and age \( > 65 \) years were significantly associated with increased mortality.

**Conclusion** Presence of head and neck pain in Type A dissection is associated with more arch involvement, intramural hematoma, and stroke. When isolating those with head and neck pain only, there appear to be a higher rate of comorbidity burden and higher overall mortality.

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**Introduction**

A 53-year-old Caucasian man was admitted to the hospital because of intense frontal headache and neck pain. In the past, he suffered from occasional migraine with aura, with predominant parietotemporal and occipital headache. The present episode started 36 hours before admission and was ushered in with a stabbing anterior chest pain lasting 10 minutes. A few minutes after the onset of chest pain, severe bifrontal headache evolved within 2 minutes, followed by additional neck pain. Moreover, the patient complained of nausea, dizziness, and flickering eyes. The headache persisted despite analgesics. Computed tomography scan showed no subarachnoid hemorrhage or aneurysm. Chest X-ray showed no abnormalities. However, transthoracic echocardiography showed a widened ascending aorta (54 mm) with an intimal flap and a severely regurgitant tricuspid aortic valve.

Acute aortic dissection is a highly lethal condition, which has an estimated incidence of 2.9 per 100,000 in western Hungary to 3.5 per 100,000 person-years in Olmsted County, Minnesota.\(^4\) Though this condition is rare compared to myocardial infarction that has an incidence of 208 cases per 100,000 person-years, aortic dissection is still the most common life-threatening disorder affecting the aorta.\(^5\) This acute syndrome is rapidly fatal if undetected with a 20% prehospital lethality rate and up to 30% in-hospital mortality.\(^7\) The mortality reaches 1 to 3% per hour in the first 48 hours and without treatment, more than 75% of patients with a Type A dissection will die in 2 weeks.\(^8\) One of the difficulties with aortic dissection is the myriad ways in which it can present. Work done by the International Registry of Acute Aortic Dissection (IRAD) has shown that though many patients present with sudden severe chest pain, pulse deficits, and pain radiation, 10 to 15% of patients do not present with pain and a subset of other patients present with nonclassic symptoms such as neurologic deficits and syncope.\(^4\)\(^,\)\(^8\)\(^,\)\(^11\)

These atypically presenting patients have a potential for delayed diagnosis, treatment, and worse outcomes compared with classically presenting patients. One of these atypical presentation symptoms is head and neck pain. Clinical teaching states that proximal dissections are more often associated with head and neck pain and neurologic symptoms due to arch involvement; however, there are little data in the published literature to support this claim.\(^12\)

We sought to analyze the truth of this clinical anecdote while also looking at the demographics, presentation, treatment, and outcomes for acute Type A dissection patients with head and neck pain.

**Materials and Methods**

The patient’s information regarding acute aortic dissection was collected from 43 centers in North America, Europe, Asia, and Australia on patients who presented between January 1996 and March 2015. These patients were identified via hospital discharge diagnosis records and the imaging databases of surgical and echocardiography laboratories. A 290-question survey, which included questions on demographics, history, physical findings, management, imaging, and outcomes, was then filled out. These data were then entered into an online database and reviewed by the IRAD coordinating center at the University of Michigan for face validity and completeness.\(^4\)

The 3,027 acute Type A dissection patients were first separated into two cohorts: those with head and neck pain (791 patients) and those without head and neck pain (2,236 patients) for our main analysis. These groups were then further analyzed regarding demographic characteristics, presentation signs and symptoms, treatment types, and outcomes. Given our results, we performed a subgroup study in patients with head and neck pain, separating that group into those who had chest and back pain versus those without chest and back pain (therefore only head and neck pain). We also performed a logistic regression of mortality in this subset controlling for head and neck pain status, preoperative hypotension, age \( > 65 \) years, site of intimal tear, and signs of intramural hematoma.

Categorical variables were analyzed using Pearson’s chi-square analysis. Continuous variables without skewed means were analyzed using two-sided t-tests. Skewed continuous variables were analyzed using the Whitney-Mann U asymptotic test. Logistic regressions models were analyzed using Hosmer-Lemeshow tests. Wald chi-square tests were used to find significance of the predictors.

**Results**

Our main analysis found several differences in the demographics between patients with head and neck pain versus those without head and neck pain as seen in Table 1. There
were interesting patterns in the quality of pain, however. Those on treatment between the two groups and neck pain were more likely to receive surgical treatment (89.8% vs. 85.2% \( p < 0.001 \)) and correspondingly less likely to undergo medical treatment alone (7.8% vs. 11.4% \( p = 0.005 \)). Significantly more patients with head and neck pain had partial arch replacement compared with those without head and neck pain (47.3% vs. 41.8% \( p = 0.017 \)) (Table 3).

While still in the hospital, patients with head and neck pain had higher rates of CVA as a complication (13% vs. 9.9% \( p = 0.016 \)). Regarding overall outcomes (Table 4), mortality among patients with head and neck was 19.5% compared with 23% in those without head and neck pain (\( p = 0.038 \)). Surgical mortality was slightly lower among patients with head and neck (14.8% and 18.8% \( p = 0.017 \)). Conversely, those patients treated medically showed higher mortality rates among patients with head and neck pain compared with those without (67.7% vs. 51.6% \( p = 0.022 \)).

In our subgroup analysis of patients with head and neck pain only versus those who had head and neck pain with chest or back, we found that those with head and neck pain only were significantly older (66.4 vs. 61.1 \( p < 0.001 \)). Furthermore, those with head and neck pain only had higher rates of diabetes (19.6% vs. 7.4% \( p = 0.003 \)), atherosclerosis (39.2% vs. 24.1% \( p = 0.018 \)), and previous coronary bypass surgery (12% vs. 1.9% \( p < 0.001 \)) compared with those who also had chest or back pain (Table 5).

At presentation, there were higher rates of coma and altered mental status (32.7% vs. 9.1% \( p < 0.001 \)), syncope (32.7% vs. 14.4% \( p = 0.001 \)), and CVA (18.4% vs. 6.6% \( p = 0.003 \)) in the head and neck pain only group as seen in Table 6. However, we found no difference in time to presentation or time to diagnosis between the two groups in cohort 2. Furthermore, there was no difference found in management type or extent of surgery between the two groups (Table 7).

Regarding outcomes, there was a significantly higher percentage of patients with head and neck pain only who had cardiac tamponade while in the hospital (30% vs. 16.6% \( p = 0.018 \)). Regarding mortality rates, patients with head and neck pain only had higher overall mortality (34.6% vs. 19.9% \( p = 0.013 \)) and higher surgical mortality (29.5% vs. 15.3% \( p = 0.014 \)) (Table 8). A logistic regression of mortality was conducted with predictive variables of head and pain, preoperative hypotension, presence of ascending intimal tear, or intramural hematomas, which found that head and neck pain status was not associated with higher mortality after controlling for the other factors (\( p = 0.36 \)) (Tables 9–11).

| Demographics | Head and neck pain group | No head and neck pain group | \( p \)-Value |
|--------------|--------------------------|-----------------------------|--------------|
| Age (overall mean) | 61.49 | 61.45 | 0.939 |
| < 40 y | 8.6 | 7.4 | 0.27 |
| > 70 y | 30 | 30.4 | 0.831 |
| Female sex | 39.8 | 31.3 | \( < 0.001 \) |
| White | 90.2 | 84 | \( < 0.001 \) |
| African American | 4.9 | 8.1 | 0.004 |
| Asian | 2.3 | 5.3 | \( < 0.001 \) |
| Family history of aortic disease | 14.5 | 8.8 | 0.002 |
| Risk factors: | | | |
| Marfan’s syndrome | 4.6 | 3.7 | 0.281 |
| Smoking | 53.7 | 51.9 | 0.549 |
| Hypertension | 72.6 | 72.5 | 0.965 |
| Atherosclerosis | 23.7 | 18.9 | 0.005 |
| Cocaine usage | 1.5 | 1.9 | 0.534 |
| Bicuspid aortic valve | 5.3 | 3.9 | 0.13 |
| Diabetes | 8.8 | 7.2 | 0.134 |
| Prior surgery: | | | |
| Coronary artery bypass grafting | 3.5 | 5.3 | 0.053 |
| Aortic valve replacement | 3.1 | 4.8 | 0.061 |
| Aortic aneurysm/dissection repair | 7 | 6.1 | 0.407 |

Note: Bold values indicate significance at \( p < 0.05 \).
Table 2 Comparison of presenting symptoms in patients with head and neck pain compared with those without head and neck pain

| Variables                                      | Head/neck pain group | No head/neck pain group | p-Value |
|------------------------------------------------|----------------------|-------------------------|---------|
| Hours from symptom onset to presentation at initial hospital | 0.75–3.33            | 0.833–3.5               | 0.189   |
| Presenting within 6 h of symptom onset          | 87.4                 | 84                      | 0.076   |
| Hours from symptom onset to presentation at initial hospital | 0.75–3.33            | 0.833–3.5               | 0.189   |
| Hours from symptom onset to diagnosis (avg)     | 2.87–12.75           | 2.66–12.19              | 0.534   |
| Hours from symptom onset to diagnosis:          |                      |                         |         |
| 0–4 h                                          | 40.6                 | 41.9                    | < 0.001 |
| 4–24 h                                         | 45.2                 | 43.1                    |         |
| 24 h                                           | 14.2                 | 15.1                    |         |
| Quality of pain:                                |                      |                         |         |
| Tearing/ripping                                | 29.9                 | 30.2                    | 0.926   |
| Sharp                                          | 49.6                 | 43.6                    | 0.024   |
| Pressure                                       | 50.4                 | 38                      | < 0.001 |
| Burning                                        | 13.8                 | 12.6                    | 0.534   |
| Abrupt onset of pain                           | 89.8                 | 78.5                    | < 0.001 |
| Back pain                                      | 43.3                 | 37.5                    | 0.005   |
| Chest pain                                     | 87.6                 | 79.3                    | < 0.001 |
| Migrating pain                                 | 20.1                 | 11                      | < 0.001 |
| Coma/altered consciousness                     | 10                   | 10.7                    | 0.598   |
| Syncope                                        | 16.7                 | 16.5                    | 0.927   |
| Cardiovascular accident                        | 7                    | 4.6                     | 0.01    |
| Congestive heart failure                       | 4.8                  | 7                       | 0.03    |
| Hypotension/shock/tamponade                    | 24.9                 | 27.6                    | 0.168   |
| Shock/tamponade                                | 8.3                  | 11.1                    | 0.03    |
| Shock                                          | 5.7                  | 7.8                     | 0.07    |
| Tamponade                                      | 2.5                  | 3.4                     | 0.266   |
| Murmur of aortic insufficiency                 | 35.8                 | 33.7                    | 0.337   |
| Any pulse deficit                              | 33                   | 34.8                    | 0.451   |
| Diagnostic imaging findings:                   |                      |                         |         |
| Arch vessel involvement                        | 44.3                 | 38                      | 0.01    |

(Continued)

Table 2 (Continued)

| Variables                                      | Head/neck pain group | No head/neck pain group | p-Value |
|------------------------------------------------|----------------------|-------------------------|---------|
| Intramural hematoma (def)                      | 11.7                 | 8.1                     | 0.003   |
| Periaortic hematoma                            | 21                   | 19.6                    | 0.463   |
| False lumen thrombosis, complete               | 9.3                  | 9                       | 0.855   |
| False lumen thrombosis, partial                | 18.9                 | 20.3                    | 0.517   |
| Coronary artery compromise                     | 12.9                 | 12.9                    | 0.978   |
| Pericardial effusion                           | 41.9                 | 41.9                    | 0.993   |
| Chest X-ray findings:                          |                      |                         |         |
| % abnormal                                     | 72.8                 | 73.3                    | 0.82    |
| Wide mediastinum                               | 53                   | 52.7                    | 0.931   |
| Abnormal aortic contour                        | 41.6                 | 41.8                    | 0.922   |
| Abnormal cardiac contour                       | 22.6                 | 24.8                    | 0.362   |
| Displacement/calciﬁcation of the aorta         | 5.4                  | 6.5                     | 0.423   |
| Pleural effusion                               | 9.3                  | 12.8                    | 0.051   |

Note: Bold values indicate significance at p < 0.05.

Table 3 Treatment modalities for the head and neck pain and no head and neck pain

| Variables                                      | Head/neck pain group | No head/neck pain group | p-Value |
|------------------------------------------------|----------------------|-------------------------|---------|
| Type of management                             |                      |                         |         |
| Type A surgical                                | 89.8                 | 85.2                    | 0.001   |
| Type A medical                                 | 7.8                  | 11.4                    | 0.005   |
| Endovascular                                   | 1.3                  | 1.8                     | 0.284   |
| Surgery                                        |                      |                         |         |
| Surgery after 24 h                             | 15.5                 | 15.4                    | 0.938   |
| Hours from symptom onset to surgery           | 6–21                 | 6–21                    | 0.244   |
| Root replacement                               | 34.7                 | 37.9                    | 0.171   |
| Ascending aortic replacement                   | 95.1                 | 93.7                    | 0.202   |
| Complete arch replacement                      | 16.4                 | 17.1                    | 0.704   |
| Partial arch replacement                       | 47.3                 | 41.8                    | 0.017   |
| Initial management of β-blockers              | 56.5                 | 56                      | 0.807   |

Note: Bold values indicate significance at p < 0.05.
Table 4 Hospital complications and overall outcomes for patients with head and neck pain compared with those without head and neck pain

| Variables                      | Head/neck pain group | No head/neck pain group | p-Value |
|-------------------------------|----------------------|-------------------------|---------|
| In-hospital complications:    |                      |                         |         |
| New neurologic deficit        | 26.5                 | 24.8                    | 0.343   |
| Cerebral vascular injury      | 13                   | 9.9                     | 0.016   |
| Transient neurodeficit        | 67.9                 | 60.1                    | 0.085   |
| Coma                          | 4.5                  | 5.5                     | 0.314   |
| Myocardial ischemia           | 85.1                 | 88.2                    | 0.063   |
| Hypotension                   | 29.4                 | 29.3                    | 0.939   |
| Cardiac tamponade             | 18.2                 | 18.6                    | 0.799   |
| Mortality:                    |                      |                         |         |
| Type A overall                | 19.5                 | 23                      | 0.038   |
| Type A surgical mortality     | 14.8                 | 18.8                    | 0.017   |
| Type A medical mortality      | 67.7                 | 51.6                    | 0.022   |
| Cause of mortality:           |                      |                         |         |
| Neurologic                    | 10.4                 | 8.2                     | 0.387   |
| Tamponade                     | 4.5                  | 6.8                     | 0.312   |
| Visceral Ischemia             | 8.4                  | 8.5                     | 0.968   |
| Bleeding                      | 5.2                  | 2.5                     | 0.095   |
| multiorgan failure            | 9.7                  | 9.7                     | 0.991   |
| Cardiac                       | 7.8                  | 9.1                     | 0.609   |
| Rupture                       | 18.2                 | 18.3                    | 0.984   |
| Unknown                       | 1.9                  | 4.1                     | 0.557   |

Note: Bold values indicate significance at p < 0.05.

Discussion

The acute and lethal nature of acute aortic dissection creates strong impetus for discovering risk factors, symptoms, and other patterns that may speed its diagnosis and decrease its mortality. Complicating this effort are the multiple presenting patterns that occur clinically.9,13–16 Head and neck pain is one of these aberrant presentation patterns, which is present in 26.1% of all Type A patients in our database to date. The pathophysiology of this pain location is not well defined in the literature. Whereas classic angina pectoris is thought to be caused by stimulation of sympathetic afferent nerves around the heart, several studies suggest that the afferent pathway of the vagus nerve may be a cause of cardiac-related head and neck pain. Stimulation of vagal afferents stimulates nerve endings in C1–C3, which corresponds to the receptive field for the neck, jaw, upper arm, and ear.17–19

Another possible mechanism of head pain might be partially explained by our findings that there were significantly more patients with arch vessel involvement and CVA in the head and neck cohort. Because the anterior and posterior circulations of the brain derive from the carotids and the vertebral arteries, respectively, which ultimately obtain blood flow from the aorta, arch vessel involvement has the potential to directly alter flow to the brain. Thus, this would represent a primary cause of the pain rather than referred pain from the heart. Studies have shown that patients with carotid or vertebral dissection can present with headache and neck pain.20,21

Regarding the higher proportion of head and neck pain found in women in our first analysis (Table 1), it has been shown in two IRAD analyses that women on average present differently than men do with aortic dissection. Women were found to present more frequently with coma and/or altered mental status compared with men.13,22 Our current data suggest that one reason for higher rates of head and neck pain among women might be more frequent CVA. A 2004 IRAD paper found that 7.9% of women with acute aortic dissection presented with CVA compared with 5.2% men, though this difference was not significant.13 When analyzing the subgroups in cohort 2, this gender preponderance of head and neck pain in women did not remain. This suggests that though women are more likely to experience head and

Table 5 Comparison of baseline demographic risk factors in patients with head and neck pain only compared with those with head and neck pain with chest or back pain

| Demographics | Head/neck pain only group | Head/neck pain + chest/back pain group | p-Value |
|--------------|---------------------------|---------------------------------------|---------|
| Age (overall mean) | 66.4 ± 10.6              | 61.1 ± 14.4                          | 0.001   |
| < 40 y       | 1 (1.9%)                  | 45 (8.3%)                            | 0.167   |
| > 70 y       | 19 (36.5%)                | 160 (29.5%)                          | 0.292   |
| Female sex   | 14 (26.9%)                | 207 (38.2%)                          | 0.108   |
| White        | 45 (91.8%)                | 481 (93.6%)                          | 0.552   |
| African American | 1 (2%)                   | 16 (3.1%)                            | 1.000   |
| Asian        | 1 (2%)                    | 9 (1.8%)                             | 0.601   |
| Family history of aortic disease | 0 (0%)                    | 30 (14.2%)                           | 0.084   |
| Risk factors: |                      |                                       |         |
| Marfan’s syndrome | 1 (2%)                    | 25 (4.7%)                            | 0.717   |
| Smoking (current) | 5 (26.3%)                 | 68 (33%)                             | 0.551   |
| Hypertension  | 39 (78%)                  | 378 (71.5%)                          | 0.324   |
| Atherosclerosis | 20 (39.2%)                | 126 (24.1%)                          | 0.018   |
| Cocaine usage | 0 (0%)                    | 8 (1.6%)                             | 1.000   |
| Bicuspid aortic valve | 2 (4.8%)                 | 29 (6.1%)                            | 1.000   |
| Diabetes     | 10 (19.6%)                | 39 (7.4%)                            | 0.003   |
| Prior surgery: |                       |                                       |         |
| Coronary artery bypass grafting | 6 (12%)                  | 10 (1.9%)                            | < 0.001 |
| Aortic valve replacement       | 1 (2%)                   | 13 (2.5%)                            | 1.000   |
| Aortic aneurysm/ dissection repair | 4 (8.2%)                | 36 (7%)                              | 0.769   |

Note: Bold values indicate significance at p < 0.05.
Table 6  Comparison of presenting symptoms in patients with head and neck pain only compared with those with head and neck pain with chest or back pain

| Variables                                           | Head/neck pain only group | Head/neck pain + chest/back pain group | p-Value |
|-----------------------------------------------------|---------------------------|----------------------------------------|---------|
| Presenting within 6 h of symptom onset              | 28 (90.3%)                | 324 (86.9%)                            | 0.782   |
| Hours from symptom onset to presentation at initial hospital | 1.25 (0.85–4.42)          | 1.25 (0.75–3.21)                       | 0.600   |
| Hours from symptom onset to diagnosis (avg)         | 5.62 (3.13–10.13)         | 5.17 (2.88–14.00)                      | 0.889   |
| Hours from symptom onset to diagnosis:              |                           |                                        | 0.770   |
| 0–4 h                                               | 10 (34.5%)                | 135 (40.1%)                            |         |
| 4–24 h                                              | 15 (51.7%)                | 151 (44.8%)                            |         |
| 24 h                                                | 4 (13.8%)                 | 51 (15.1%)                             |         |
| Quality of pain:                                    |                           |                                        |         |
| Tearing/ripping                                     | 3 (12.5%)                 | 116 (35.3%)                            | 0.024   |
| Sharp                                               | 11 (44%)                  | 169 (50.8%)                            | 0.515   |
| Pressure                                            | 11 (39.3%)                | 172 (55.3%)                            | 0.103   |
| Burning                                              | 5 (20.8%)                 | 42 (15.3%)                             | 0.478   |
| Abrupt onset of pain                                 | 43 (84.3%)                | 477 (90.2%)                            | 0.19    |
| Back pain                                           | 0 (0%)                    | 256 (47.2%)                            | < 0.001 |
| Chest pain                                          | 0 (0%)                    | 521 (96.1%)                            | < 0.001 |
| Migrating pain                                       | 2 (4%)                    | 112 (21.5%)                            | 0.001   |
| Coma/ altered consciousness                         | 16 (32.7%)                | 47 (9.1%)                              | < 0.001 |
| Syncope                                             | 17 (32.7%)                | 77 (14.4%)                             | 0.001   |
| Cardiovascular accident                              | 9 (18.4%)                 | 34 (6.6%)                              | 0.003   |
| Congestive heart failure                             | 3 (6.4%)                  | 23 (4.5%)                              | 0.471   |
| Hypotension/shock/tamponade                         | 14 (28.6%)                | 126 (24.3%)                            | 0.505   |
| Shock/tamponade                                      | 2 (4.1%)                  | 43 (8.3%)                              | 0.412   |
| Shock                                                | 1 (2%)                    | 31 (6%)                                | 0.510   |
| Tamponade                                            | 1 (2%)                    | 12 (2.3%)                              | 1.000   |
| Murmur of aortic insufficiency                       | 17 (36.2%)                | 178 (38.5%)                            | 0.751   |
| Any pulse deficit                                    | 11 (33.3%)                | 111 (27.8%)                            | 0.499   |
| Diagnostic imaging findings:                        |                           |                                        |         |
| Arch vessel involvement                              | 23 (56.1%)                | 169 (41.8%)                            | 0.079   |
| Intramural hematoma (def)                            | 5 (9.6%)                  | 62 (11.6%)                             | 0.663   |
| Periaortic hematoma                                  | 7 (14.9%)                 | 103 (23.8%)                            | 0.168   |
| False lumen thrombosis, complete                     | 0 (0%)                    | 34 (10.1%)                             | 0.093   |
| False lumen thrombosis, partial                      | 6 (21.4%)                 | 62 (18.4%)                             | 0.692   |
| Coronary artery compromise                           | 3 (7%)                    | 52 (13.6%)                             | 0.336   |
| Pericardial effusion                                 | 23 (45.1%)                | 203 (42.3%)                            | 0.700   |
| Chest X-ray findings:                                |                           |                                        |         |
| % abnormal                                          | 30 (78.9%)                | 301 (75.3%)                            | 0.612   |
| Wide mediastinum                                     | 18 (48.6%)                | 199 (52.5%)                            | 0.654   |
| Abnormal aortic contour                              | 15 (40.5%)                | 153 (41.2%)                            | 0.934   |
| Abnormal cardiac contour                             | 9 (24.3%)                 | 76 (20.7%)                             | 0.601   |
| Displacement/calciﬁcation of the aorta              | 4 (10.8%)                 | 20 (5.4%)                              | 0.258   |
| Pleural effusion                                     | 1 (2.7%)                  | 35 (9.4%)                              | 0.231   |

Note: Bold values indicate significance at p < 0.05.
neck pain overall, those women who have head and neck pain are equally likely to present with chest pain and back pain or with head and neck pain only.

An unexpected finding in our first analysis was the higher rates of chest pain and back pain in the head and neck group along with higher rates of all of the various permutations of pain types such as tearing, sharp, and migrating (Table 2). This may be because “worst-ever pain” in the chest, which radiates to the back, is still the predominant way that patients experience acute aortic dissection, it will remain the most prevalent presentation despite the presence of head and neck pain.16,23,24 On the other hand, a reason that the non–head and

### Table 7 Treatment modality used for those with head and neck pain only compared with those with head and neck pain and chest or back pain

| Variables                  | Head/neck pain only group | Head/neck pain + chest/back pain group | p-Value |
|----------------------------|----------------------------|----------------------------------------|---------|
| Type of management:        |                            |                                        |         |
| Type A surgical            | 44 (84.6%)                 | 491 (90.6%)                            | 0.169   |
| Type A medical             | 7 (13.5%)                  | 42 (7.7%)                              | 0.153   |
| Endovascular               | 0                          | 3 (0.6%)                               | 1       |
| Surgery:                   |                            |                                        |         |
| Surgery after 24 h         | 9 (20%)                    | 79 (16.2%)                             | 0.51    |
| Hours from symptom onset to surgery | 11 (7.75–25.17)          | 10.64 (6.73–23.63)                    | 0.481   |
| Root replacement           | 14 (34.1%)                 | 1                                      | 0.793   |
| Ascending aortic replacement | 42 (93.3%)                | 443 (94.5%)                            | 0.733   |
| Complete arch replacement  | 6 (14%)                    | 64 (14.4%)                             | 0.93    |
| Partial arch replacement   | 20 (44.4%)                 | 20 (46.4%)                             | 0.798   |
| Initial management of β-blockers | 21 (47.7%)             | 268 (53.5%)                            | 0.463   |

### Table 8 Hospital complications and overall outcomes for patients with head and neck pain only compared with those with head and neck pain with chest or back pain

| Variables                  | Head/neck pain only group | Head/neck pain + chest/back pain group | p-Value |
|----------------------------|----------------------------|----------------------------------------|---------|
| In-hospital complications: |                            |                                        |         |
| New neurologic deficit     | 19 (36.5%)                 | 144 (27.5%)                            | 0.167   |
| Cerebral vascular injury   | 14 (26.9%)                 | 71 (13.8%)                             | 0.011   |
| Transient neurodeficit     |                            |                                        |         |
| Coma                       | 4 (7.7%)                   | 24 (4.7%)                              | 0.312   |
| Myocardial ischemia        | 4 (8.3%)                   | 63 (12.6%)                             | 0.494   |
| Hypotension                | 16 (31.4%)                 | 163 (31.5%)                            | 0.989   |
| Cardiac tamponade          | 15 (30%)                   | 86 (16.6%)                             | 0.018   |
| Mortality:                 |                            |                                        |         |
| Type A overall             | 18 (34.6%)                 | 108 (19.9%)                            | 0.013   |
| Type A surgical mortality  | 13 (29.5%)                 | 27 (15.3%)                             | 0.014   |
| Type A medical mortality   | 5 (71.4%)                  | 28 (66.7%)                             | 1       |
| Cause of mortality:        |                            |                                        |         |
| Neurologic                 | 3 (16.7%)                  | 13 (12%)                               | 0.701   |
| Tamponade                  | 0                          | 6 (5.6%)                               | 0.593   |
| Visceral ischemia          | 3 (16.7%)                  | 9 (8.3%)                               | 0.377   |
| Bleeding                   | 1 (5.6%)                   | 6 (5.6%)                               | 1       |
| Multiorgan failure         | 1 (5.6%)                   | 6 (5.6%)                               | 1       |
| Cardiac                    | 0 (5.6%)                   | 9 (8.3%)                               | 1       |
| Rupture                    | 1 (5.6%)                   | 26 (24.1%)                             | 0.118   |
| Unknown                    | 6 (33.3%)                  | 31 (28.7%)                             | 0.69    |

Note: Bold values indicate significance at p < 0.05.
Table 9 Logistic regression model of mortality with independent variables of head and neck pain status, age > 65 years, preoperative hypotension, ascending intimal tear, intramural hematoma

| Variables                           | β-Coefficient | p-Value | Risk ratio | 95% confidence interval: lower | 95% confidence interval: upper |
|-------------------------------------|---------------|---------|------------|-------------------------------|-------------------------------|
| Head and neck and chest or back pain| -0.396        | 0.359   | 0.673      | 0.289                         | 1.568                         |
| Age > 65 y                          | 0.806         | 0.003   | 2.238      | 1.318                         | 3.802                         |
| Preoperative hypotension            | 1.395         | 0.000   | 4.037      | 2.348                         | 6.942                         |
| Ascending intimal tear              | -0.837        | 0.002   | 0.433      | 0.252                         | 0.745                         |
| Intramural hematoma                 | -0.705        | 0.05    | 0.494      | 0.244                         | 1.001                         |
| Constant                            | -1.277        | 0.004   | 0.279      |                               |                               |

Note: Bold values indicate significance at p < 0.05.

Table 10 Hosmer-Lemeshow test for model fit

| Chi-square | Degrees of freedom | Significance |
|------------|--------------------|--------------|
| 10.495     | 8                  | 0.232        |

Note: Bold values indicate significance at p < 0.05.

Table 11 Area under the curve for the logistic regression model

| Area under the curve | 0.736 |

Despite the potential for delayed diagnosis, we found no delay to diagnosis or treatment in either cohort. Furthermore, in cohort 1, those with head and neck pain had lower overall mortality and lower surgical mortality. This was an unexpected finding given the atypical presentation. However, given the fact that those with head and neck pain had a higher rate of chest pain and back pain than the group without head and neck pain, we wondered whether the presence of chest and back pain obscured the impact of having head and neck pain. Thus, we conducted a second analysis (cohort 2) with head and neck pain only versus those with head and neck pain with chest or back pain to see the effect of having only head and neck pain (without the influence of chest pain or back pain). We found in the second analysis that there was significantly higher overall and surgical mortality in the head and neck pain only group.

Reasons for the difference in mortality between cohorts 1 and 2 are not clear. Despite those in cohort 1 with head and neck pain having higher rates of the classic symptoms such as chest pain and back pain, we did not see any improvement in time to diagnosis in that group, which would explain their lower mortality. On the other hand, in cohort 2, those who experienced only head and neck pain were older, had higher rates of atherosclerosis, diabetes, and had more coronary artery bypass grafting operations, which represent several important risk factors for mortality.

In conclusion, we have shown that patients with head and neck pain have higher rates of proximal arch involvement and stroke, which adds credence to classic clinical teaching about the association of head and neck pain with arch involvement. Furthermore, patients with head and neck pain overall tend to have classic dissection symptoms and thus have no delay in diagnosis and also lower mortality compared with those without head and neck pain. However, in our subgroup analysis (cohort 2), we showed that those with isolated head and neck pain tend to have worse comorbidities, more neurologic symptoms on presentation, and worse overall and surgical mortality. This higher mortality may be partially explained by the older age and more preoperative hypotension in the head and neck pain only group. These patients, though a small fraction of our Type A dissection population, represent an area for added vigilance and improvement in our pursuit of better care of acute aortic dissection patients.

Our study has several limitations. IRAD is composed of patients in academic referral centers and may not represent the overall population of aortic dissection patients. In addition, patients with abnormal presentations may pass away prior to diagnosis or transfer to tertiary aortic centers and are thus underrepresented in our population. Furthermore, given our
international scope, there is possible variation in treatment patterns, which may complicate outcomes measurements.

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Conflict of Interest
The authors declare no conflict of interest related to this article.

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References
1 Mathys J, Lachat M, Herren T. Headache as a manifestation of a life-threatening vascular disorder. Headache 2004;44(07):706–709
2 Mészáros I, Mórócz J, Szlávi J, et al. Epidemiology and clinicopathology of aortic dissection. Chest 2000;117(05):1271–1278
3 Clouse WD, Hallett JW Jr, Schaff HV, et al. Acute aortic dissection: population-based incidence compared with degenerative aortic aneurysm rupture. Mayo Clin Proc 2004;79(02):176–180
4 Hagan PG, Nienaber CA, Isselbacher EM, et al. The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. JAMA 2000;283(07):897–903
5 Braverman AC. Acute aortic dissection: clinician update. Circulation 2010;122(02):184–188
6 Yeh RW, Sidney S, Chandra M, Sorel M, Selby JV, Go AS. Population trends in the incidence and outcomes of acute myocardial infarction. N Engl J Med 2010;362(23):2155–2165
7 Olsson C, Thelin S, Stähle E, Ekbom A, Granath F. Thoracic aortic aneurysm and dissection: increasing prevalence and improved outcomes reported in a nationwide population-based study of more than 14,000 cases from 1987 to 2002. Circulation 2006;114 (24):2611–2618
8 Elefteriades JA, Olin JW, Halperin JL. Diseases of the aorta. In: Fuster V, Walsh RA, Harrington RA, eds. Hurst’s The Heart, 13th ed. New York, NY: McGraw-Hill; 201 :chap 106. http://accessmedicine.mhmedical.com/content.aspx?bookid¼3768&Sectionid¼40279845. Accessed March 17, 2016.
9 Harris KM, Strauss CE, Eagle KA, et al; International Registry of Acute Aortic Dissection (IRAD) Investigators. Correlates of delayed recognition and treatment of acute type A aortic dissection: the International Registry of Acute Aortic Dissection (IRAD). Circulation 2011;124(18):1911–1918
10 Woo KM, Schneider JH. High-risk chief complaints I: chest pain—the big three. Emerg Med Clin North Am 2009;27(04):685–712. x
11 Golledge J, Eagle KA. Acute aortic dissection. Lancet 2008;372 (9632):55–66
12 Stöllberger C, Finsterer J, Fousek C, Waldenberger FR, Haumer H, Lorenz W. Headache as the initial manifestation of acute aortic dissection type A. Cephalalgia 1998;18(08):583–584
13 Nienaber CA, Fattori R, Mehta RH, et al; International Registry of Acute Aortic Dissection. Gender-related differences in acute aortic dissection. Circulation 2004;109(24):3014–3021
14 Klopmas M. Does this patient have an acute thoracic aortic dissection? JAMA 2002;287(17):2262–2272
15 Park SW, Hutchison S, Mehta RH, et al. Association of painless acute aortic dissection with increased mortality. Mayo Clin Proc 2004;79(10):1252–1257
16 Nienaber CA, Clough RE. Management of acute aortic dissection. Lancet 2015;385(9970):800–811
17 Foreman RD. Mechanisms of cardiac pain. Annu Rev Physiol 1999;61:143–167
18 Myers DE. Vagus nerve pain referred to the craniofacial region. J Dent Res 2008;94(04):187–189
19 Chandler MJ, Zhang J, Qin C, Yuan Y, Foreman RD. Intrapericardial injections of algogenic chemicals excite primate C1–C2 spinohyalamic tract neurons. Am J Physiol Regul Integr Comp Physiol 2000;279(02):R560–R568
20 Blum CA, Yaghi S. Cervical artery dissection: a review of the epidemiology, pathophysiology, treatment, and outcome. Arch Neurosci 2015;2(04):e26670
21 Grotta JC. Clinical practice. Carotid stenosis. N Engl J Med 2013;369(12):1143–1150
22 Philip S, Pape L, Suzuki T, et al. Changes in gender-related differences in acute aortic dissection over time. J Am Coll Cardiol 2014;63(12):A2059
23 Pape LA, Awais M, Woznicki EM, et al. Presentation, diagnosis, and outcomes of acute aortic dissection: 17-year trends from the International Registry of Acute Aortic Dissection. J Am Coll Cardiol 2015;66(04):350–358
24 Thrumurthy SG, Karthikesalingam A, Patterson BO, Holt PJ, Thompson MM. The diagnosis and management of aortic dissection. BMJ 2011;344:d8290
25 Tolenaar JL, Hutchison SJ, Montgomery D, et al. Painless type B aortic dissection: insights from the International Registry of Acute Aortic Dissection. Aorta (Stamford) 2013;1(02):96–101
26 Chiariello M, Indolfi C. Silent myocardial ischemia in patients with diabetes mellitus. Circulation 1996;93(12):2089–2091
27 Khafaji HAH, Suwaidi JMA. Atypical presentation of acute and chronic coronary artery disease in diabetics. World J Cardiol 2014;6(08):802–813
28 Weiner DA, Ryan TJ, Parsons L, Fischer LD, Chaitman BR, Sheffield LT. Prevalence and prognostic significance of silent and symptomatic ischemia after coronary bypass surgery: a report from the Coronary Artery Surgery Study (CASS) randomized population. 22nd Bethesda Conference: Congenital heart disease after childhood: An expanding patient population 18.2 (1991):343–348. Web.
29 Li SF, Greenwald PW, Gennis P, Bijur PE, Gallagher EJ. Effect of age on acute pain perception of a standardized stimulus in the emergency department. Ann Emerg Med 2001;38(06):644–647
30 Weintrab WS, Clements SD Jr, Crisco JV, et al. Twenty-year survival after coronary artery surgery: an institutional perspective from Emory University. Circulation 2003;107(09):1271–1277
31 Morgan CL, Currie CJ, Peters JR. Relationship between diabetes and mortality: a population study using record linkage. Diabetes Care 2000;23(08):1103–1107