Acute type A aortic dissection: timeline between onset and treatment

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Background: Patients with acute aortic dissection are affected with high early mortality. However, only limited data is available to delineate the factors that contribute to initial delays in establishing the diagnosis and treatment.

Methods: In this single-centre, retrospective analysis, we reviewed 52 consecutive patients with acute type A aortic dissection (ATAAD) presenting at our institution (General Hospital Sint-Jan Bruges, Belgium) from January 2009 to October 2019. After thorough review of all medical records, a timeline was drawn for every patient, reflecting time delays from onset of symptoms to diagnosis and treatment. These data were supplemented with patients clinical characteristics. Statistical analysis using the Mann-Whitney U test ($P<0.05$) and the Kruskal-Wallis test ($P<0.05$) for independent samples were used.

Results: The median time elapsed from 'onset-to-presentation' was 126.5 min (61–300 min), from 'presentation-to-diagnosis' 85.5 min (35.5–209 min), from 'diagnosis-to-surgery' 210 min (74–320.75 min) and from 'onset-to-knife' 600 min (337.5–1,125 min). The time from 'diagnosis-to-surgery' was significantly longer ($P<0.05$) than any of the other time-related variables. Gender, the mean amount of imaging studies needed to reach definitive diagnosis and the imaging study that provided definitive diagnosis had a significant influence on the 'onset-to-knife' time. Only the amount of imaging studies needed to reach definitive diagnosis was significantly related to the 'presentation-to-diagnosis' time. We report a 30-day mortality of 7.7% and an in-hospital mortality of 11.5%.

Conclusions: Clinical knowledge and awareness remain very important to contribute to an early admission, followed by sharp and accurate diagnosis to improve outcome. Improvement in logistics should lead to shorter 'diagnosis-to-surgery' time. Owing to the time-dependent properties of ATAAD management, a (national) system of aortic dissection care should be drafted.

Keywords: Acute type A aortic dissection (ATAAD); timeline; delay in diagnosis and treatment

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Introduction

In life, time and even seconds, do matter. Especially in certain domains of medicine, losing time means losing lives. Stroke and acute coronary syndrome (ACS) are well-known examples. In cardiothoracic surgery, acute type A aortic dissection (ATAAD) is the most life-threatening emergency, requiring immediate surgical intervention. The incidence of ATAAD is 2.53 cases per 1,000,000 people per year (1). Mortality rates prior to hospital arrival range between 20–60% (2,3). When presenting alive to a hospital, mortality rates of 10.3% in the first 6 h, 21.4% within 24 h and 45.2% within 30 days are reported (2,3), which is similar to the earlier observed mortality rate of 1% per hour during the initial 48 hours by Anagnostopoulos *et al.* (4) Although the methodology of the older literature on incidence and mortality of ATAAD could be criticized, they are confirmed in more recent reports (5-10). As pathogenesis is reasonably well defined, we know that patients die from aortic rupture, tamponade, acute aortic insufficiency and malperfusion syndromes (11). In contrast the 30-day survival rate for patients with efficient diagnosis and optimal care approaches 90% (12). We know from the International Registry of Acute Aortic Dissection (IRAD) (2) that the median time from presentation to diagnosis for all acute aortic dissection patients is over 4.3 hours. Contrary to what one might expect, death prior to hospital arrival or within 6 and 24 h of admission did not change much over time, indicating that advancement in diagnostic technology and urgent medical care had only minimal effects on early mortality (4,13). This can be explained because of the relative infrequency of ATAAD, together with clinical presentations that may vary and mimic more common problems such as ACS (which could lead to exposure to antithrombotic agents) or stroke (14). There are few studies, trying to define clinical and diagnostic factors that could help reduce time delay between onset of symptoms, diagnosis and surgery (2,15-18). They show that improved physician awareness of typical and atypical presentation of acute aortic dissection, low threshold for tomographic imaging and prompt transport to a tertiary hospital or department of cardiac surgery where they can initiate surgery immediately could reduce crucial time variables. For now, it seems that up to 35% of patients are misdiagnosed on initial presentation (1). Once diagnosed, delays to surgery are mainly due to hospital organization in providing an available operating theatre with trained personnel or in absence of the necessary facilities or expertise, by transfer to a tertiary care centre (19). A promising approach in reducing delay is demonstrated by a multidisciplinary, regional protocol to standardize the care for ATAAD (2,16).

It is important to remember that delay to surgery does not automatically indicate a failure of care systems. As previously suggested in literature, some subsets of patients may benefit from delayed operation in order to perform additional imaging or address comorbidities (20-24).

However, an accurate diagnosis made in a timely manner is still the best opportunity for a positive health outcome because clinical decisions and treatment will be tailored to a correct understanding of the problem (25). This is translated in the door-to-needle time of less than 60 minutes in case of stroke and ACS.

The purpose of this single-centre retrospective study of all ATAADs over a 10-year period was first to determine delays in presentation, diagnosis and treatment, which are still encountered despite unprecedented possibilities and technologies in medicine and secondly to clarify factors related to these delays and come up with possible solutions to avoid them in the future. We present the following article in accordance with the STROBE reporting checklist (available at https://jovs.amegroups.com/article/view/10.21037/jovs-20-54/rc).

Methods

Study design

All patients who presented at our institution between January 2009 and October 2019 with an ATAAD were included in this single-centre retrospective study. Aside from patient characteristics, a timeline was drawn for each patient including the time of onset of symptoms, arrival at the referring hospital, arrival at our own hospital (General Hospital Sint-Jan, in Bruges, Belgium), time of definitive diagnosis and start of surgery. All these data were obtained through thorough medical record review. Because of the retrospective design and the data retrieved from hospital medical record system only, informed consent was not required. Patient's personal data were secured. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional ethics board at General Hospital Sint-Jan, in Bruges, Belgium (B2020049000030).

Statistical analysis

Statistical analysis was performed using SPSS v26 (IBM

Corp., Armonk, NY). Regarding the time-related variables, the Kruskal-Wallis test (P<0.05) and the Mann-Whitney U test (P<0.05) was used for non-parametric, independent samples.

Results

Between January 2009 and October 2019, 52 patients with ATAAD were treated at the department of cardiac surgery in General Hospital Sint-Jan, Bruges, Belgium. Results are summarized in *Table 1*.

Patient characteristics

The mean age was 66 years (22–89 years). There were 16 female and 36 male patients. Medical history related to ATAAD was negative in 40/52 patients (76.9%). The remaining 12 patients had known annuloaortic ectasia (2/12), aortic aneurysm (1/12), aortic dilatation (1/12), aortic valve insufficiency grade I-II (1/12), polymyalgia rheumatica (2/12), psoriasis arthritis (1/12), rheumatoid arthritis (1/12), previous cardiac surgery (2/12) and refractory hypertension (1/12). The majority of patients did not take or receive any antithrombotic therapy [38/52 (73.1%)]. However 7/52 patients (13.5%) received dual antiplatelet therapy shortly before surgery and 5/52 (9.6%) were on acetylsalicylic acid preoperatively and only 1/52 (1.9%) was on clopidogrel.

Signs and symptoms

The most predominant symptom at presentation was retrosternal pain, present in 39/52 patients (75%). The nature of the pain was reported as 'abrupt' in the majority of patients [46/52 (88.5%)]. Syncope is the second most common symptom present in 7/52 (13.5%), followed by interscapular pain and abdominal pain in 6/52 (11.5%). Other symptoms are paresis in a lower limb, stroke, coma, nausea & vomiting, a fall and a newly diagnosed heart murmur (*Figure 1*).

Preoperative intubation occurred in 7/52 patients (13.5%), 4/52 (7.7%) endured CPR, 10/52 (19.2%) were in shock and 9/52 (17.3%) developed a cardiac tamponade.

Laboratory tests and electrocardiogram

Troponin levels were determined in 41 subjects and were positive in only 4/52 (7.7%).

D-dimers were determined in 29/52 patients (55.8%). In 27/29 patients (93.1%) they were elevated.

Ischaemia on electrocardiogram was seen in only 3/52 patients (5.7%).

Imaging studies

One third of patients was diagnosed using 1, 2 or 3 imaging studies, respectively 16/52 (30.8%), 19/52 (36.5%) and 15/52 (28.8%). The mean variety of imaging studies needed to establish the definitive diagnosis was 1.73. The first imaging study performed after initial evaluation of the patient was a computed tomography of the chest in almost half of the patients [24/52 patients (46.2%)]. The second most prevalent imaging study was a chest X-ray in 17/52 patients (32.7%). Other imaging studies were less frequent, including abdominal X-ray, computed tomography of the abdomen, abdominal echography, transthoracic echocardiography and coronary angiography.

Definitive diagnosis was reached after performing a computed tomography of the chest in 48/52 patients (92.3%), followed by coronary angiography in 2/52 (3.8%) and transthoracic and transoesophageal echocardiography both in 1/52 (1.9%).

Outcome

We report a 30-day mortality of 7.7% and an in-hospital mortality of 11.5%. There was no significant difference in 30-day mortality or in-hospital mortality between the long or short 'onset-to-knife' time or 'presentation-to-diagnosis' time (*Table 1*).

Timeline

The main focus of our study was reporting the delays between onset of symptoms and start of surgery. Therefore, a timeline was drafted for every patient (*Figure 2*). We calculated the 'onset-to-presentation' time (= time from onset of symptoms to presentation at a hospital), the 'presentation-to-diagnosis' time (= time from presentation at a hospital to definitive diagnosis), the interhospital transfer time (= time elapsed from initial transfer call to arrival at our hospital), the 'diagnosis-to-surgery' time (supplemented with the 'arrival-at-our-institution-to-surgery' time) and the 'onset-to-knife' time (= total sum of 'onset-to-presentation' time, 'presentation-to-diagnosis' time and 'diagnosis-to-surgery' time). The 'onset-to-presentation' time and the 'presentation-to-diagnosis'

Table 1 Overview of clinical characteristics and diagnostic tests performed in patients presenting with acute type A aortic dissection and their influence on early or late diagnosis and treatment

Characteristics	Subtypes	Total		'Presentation-to-diagnosis' time					'Onset-to-knife' time				
		N	%	Early (<85.5 min. median)	%	Late (>85.5 min)	%	P value	Early (<600 min. median)	%	Late (>600 min. median)	%	P value
N		52		26		26			27		25		
Age (years)		66		63.5		69.42		0.223	63.59		69.56		0.094
Gender	Male	36/52	69.2	21/26	80.8	15/26	57.7	0.74	22/27	81.5	14/25	56.0	0.049
Medical history	Negative	40/52	76.9	20/26	76.9	20/26	76.9	0.795	21/27	77.8	19/25	76.0	0.611
Initial presentation	Referring hospital	27/52	51.9	13/26	50	14/26	53.8	0.783	14/27	51.9	13/25	52.0	0.992
Initial symtoms								0.864					0.640
	Retrosternal pain	39/52	75.0	19/26	73.1	20/26	76.9		20/27	74.1	19/25	76.0	
	Interscapular pain	6/52	11.5	2/26	7.7	4/26	15.4		3/27	11.1	3/25	12.0	
	Syncope	7/52	13.5	3/26	11.5	4/26	15.4		4/27	14.8	3/25	12.0	
	Abdominal pain	6/52	11.5	2/26	7.7	4/26	15.4		2/27	7.4	4/25	16.0	
	Paresis lower extremity	2/52	3.8	1/26	3.8	1/26	3.8				2/25	80	
	Stroke	1/52	1.9	1/26	3.8				1/27	3.7			
	Comatose	1/52	1.9	1/26	3.8						1/25	4.0	
	Nausea & vomiting	1/52	1.9			1/26	3.8				1/25	4.0	
	Fall	1/52	1.9	1/26	3.8				1/27	3.7			
	Newly diagnosed heart murmur	1/52	1.9	1/26	3.8				1/27	3.7			
	Intubation	7/52	13.5	4/26	15.4	3/26	11.5		3/27	11.1	4/25	16.0	
	Reanimation	4/52	7.7	2/26	7.7	2/26	7.7		2/27	7.4	2/25	8.0	
	Shock	10/52	19.2	6/26	23.1	4/26	15.4		5/27	18.5	5/25	20.0	
	Tamponade	9/52	17.3	4/26	15.4	5/26	19.2		3/27	11.1	6/25	24.0	
Initial pain	Abrupt	46/52	88.5	23/26	88.5	23/26	88.5	0.960	25/27	92.6	21/25	84.0	0.305
	Gradually	1/52	1.9	1/26	3.8				1/27	3.7			
Laboratory results	Positive troponins	4/52	7.7	1/26	3.8	3/26	11.5	0.454			4/25	16.0	0.253

Table 1 (*continued*)

Table 1 (*continued*)

Characteristics	Subtypes	Total		'Presentation-to-diagnosis' time					'Onset-to-knife' time				
		N	%	Early (<85.5 min. median)	%	Late (>85.5 min)	%	P value	Early (<600 min. median)	%	Late (>600 min. median)	%	P value
	Positive D-dimers	27/52	51.9	14/26	53.8	13/26	50	0.983	15/27	55.6	12/25	48.0	0.423
ECG ischemia	Positive	3/52	5.7			3/26	11.5	0.723	2/27	7.4	1/25	4.0	0.688
Imaging studies (n, mean)				1.73		2.38		0.008	1.74		2.40		0.008
Diagnosis	TTE	1/52	1.9	1/26	3.8	1/26	3.8	0.276	1/27	3.7			0.047
	TEE	1/52	1.9						1/27	3.7			
	CT thorax	48/52	92.3	23/26	88.5	25/26	96.2		23/27	85.2	25/25	100	
	Coronarography	2/52	3.8	2/26	7.7				2/27	7.4			
Antithrombotic therapy	DAPT	7/52	13.5	2/26	7.7	5/26	19.2	0.459	2/27	7.4	5/25	20.0ù	
	ASA	5/52	9.6	3/26	11.5	2/26	7.7		4/27	14.8	1/25	4.0	0.724
	Clopidogrel	1/52	1.9			1/26	3.8		1/27	3.7			
	None	38/52	73.1	21/26	80.8	17/26	65.4		19/27	70.4	19/25	76.0	
	Unknown	1/52	1.9			1/26	3.8		1/27	3.7			
30-day mortality		4/52	7.7	3/26	11.5	1/26	3.8	0.303	2/27	7.4	2/25	8.0	0.937
In-hospital mortality		6/52	11.5	4/26	15.4	2/26	7.7	0.390	3/27	11.1	3/25	12.0	0.921

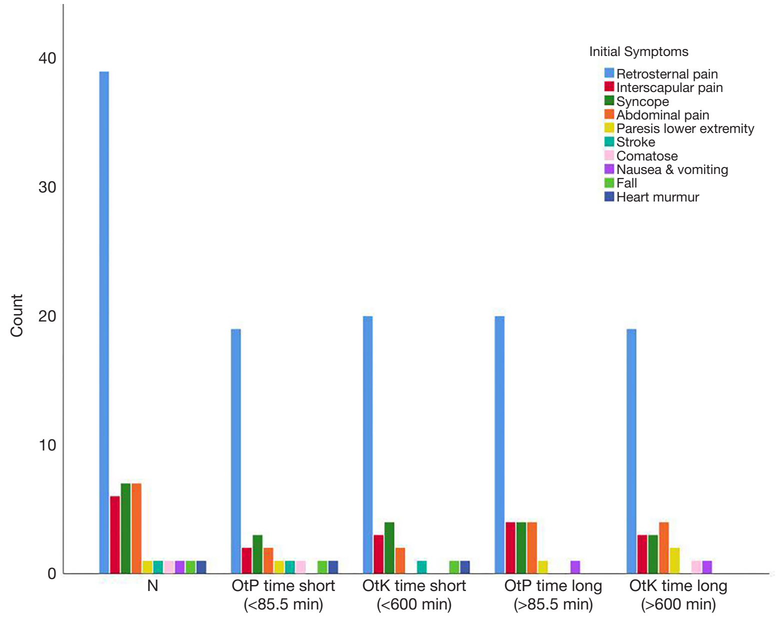

Figure 1 Overview of initial symptoms, stratified between 'short' and 'long' 'onset-to-presentation' time and 'onset-to-knife' time. N, results of total sample size; OtP time, 'onset-to-presentation' time; OtK time, 'onset-to-knife' time.

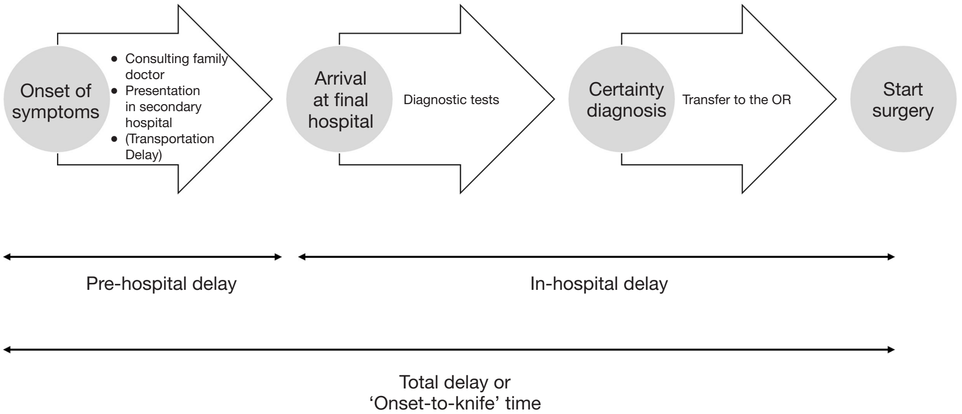

Figure 2 Timeline of delays encountered from onset of symptoms to start of surgery in patients with acute type A aortic dissection.

time was subdivided regarding presentation at our own institution or at a surrounding/referring hospital. More than half of the patients (27/52 or 51.9%) were referred after admission and diagnosis at a surrounding/referring hospitals. The remaining 48.1% presented at our own centre directly. The median time was calculated for all of the time-related variables above. They are summarized in *Table 2* and visualized in *Figure 3*.

Statistical analysis shown in *Table 3* revealed a significantly longer time interval from 'diagnosis-to-surgery' compared to all the other time-related variables reported.

There was no statistical significant difference between the 'onset-to-presentation' time or the 'presentation-to-diagnosis' time at a referring hospital compared to our institution.

There was a median pre-hospital delay of 126.5 min (61–300 min, interquartile range), a median interhospital delay of 90 min (67–136.5 min) and a median in-hospital delay of 210 min (132.5–309.75 min). This resulted in a median 'onset-to-knife' time of 600 min (337.5–1,125 min).

Table 2 Overview of the delays encountered in patients with acute type A aortic dissection

Delay [time (min)]	Q25	Q75	Median
‘Onset-to-presentation’ time	61	300	126.5
Referring hospital	61.25	285	126.5
Our institution	61	718	117
‘Presentation-to-diagnosis’ time	35.5	209	85.5
Referring hospital	46	208	90
Our institution	24	460	64
Interhospital transfer time	67	136.5	90
‘Arrival-at-our institution-to-surgery’ time	74	320.75	144.5
‘Diagnosis-to-surgery’ time	132.5	309.75	210
‘Onset-to-knife’ time	337.50	1,125.00	600

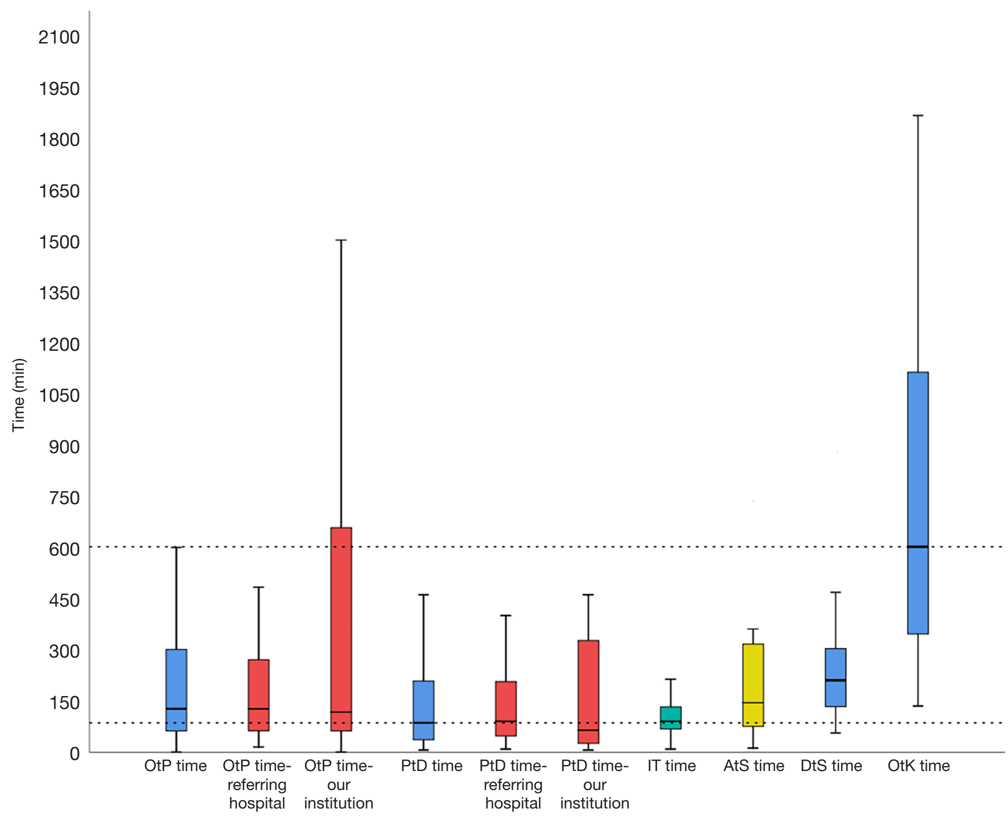

Figure 3 Boxplot of the different time delays encountered in patients presenting with acute type A aortic dissection, resulting in a ‘onset-to-knife’ time with a median of 600 min. OtP time, ‘onset-to-presentation’ time; PtD time, ‘presentation-to-diagnosis’ time; IT time, interhospital transfer time; AtS, ‘arrival-at-our-institution-to-surgery’ time; DtS time, ‘diagnosis-to-surgery’ time; OtK time, ‘onset-to-knife’ time.

Table 3 Results of statistical analysis of the delays encountered in patients with acute type A aortic dissection

Statistical analysis between delays	Mann-Whitney U test (P<0.05)	Kruskal-Wallis test (P<0.05)
'Onset-to-presentation' – 'presentation-to-diagnosis' time	0.83	
'Onset-to-presentation' – interhospital transfer time	0.167	
'Onset-to-presentation' – 'arrival-at-our-institution-to-surgery' time	0.269	
'Onset-to-presentation' – 'diagnosis-to-surgery' time	0.030	
'Presentation-to-diagnosis' time – interhospital transfer time	0.761	
'Presentation-to-diagnosis' time – arrival-at-our-'institution-to-surgery' time	0.005	
'Presentation-to-diagnosis' time – 'diagnosis-to-surgery' time	0.000	
Interhospital transfer time – 'arrival-at-our-institution-to-surgery' time	0.015	
Interhospital transfer time – 'diagnosis-to-surgery' time	0.000	
'Arrival-at-our-institution-to-surgery' time – 'diagnosis-to-surgery' time	0.195	
Overall comparison		0.000

To determine which factors contribute to a tardy or quick 'onset-to-knife' time, we grouped the variable 'onset-to-knife' time into a short, i.e., less than 600 min [median 'onset-to-knife' time)] and a long time interval of more than 600 min. Results are presented in *Table 1* and seen in *Figure 4*.

We found statistical significance for gender, in favour of a short 'onset-to-knife' time in males (P=0.049) (*Figure 4A*), the variety of imaging studies needed to reach definitive diagnosis (more imaging studies in the long 'onset-to-knife' time) (P=0.008) (*Figure 4B*) and in the imaging study that led to definitive diagnosis (P=0.047) (*Figure 4C*).

The same analysis was done regarding tardy and quick 'presentation-to-diagnosis' time. A short 'presentation-to-diagnosis' time was defined as less than 85.5 min (median 'presentation-to-diagnosis' time). A long 'presentation-to-diagnosis' time is greater than 85.5 min. We could only find statistical significance in the variety of imaging studies needed to reach definitive diagnosis (*Figure 4D,E,F*).

Finally we looked at the evolution in 'presentation-to-diagnosis' time and 'onset-to-knife' time over the 10-year period. The result was not significant and is visualised in *Figure 5*.

Discussion

In any medical emergency, the patients experience a range of delays between onset of symptoms, diagnosis and treatment. Regarding the delays observed in ATAAD, literature is scarce (2,15-18).

In the pre-hospital phase the 'onset-to-presentation' time is determined by the lack of recognition or appropriate response to initial symptoms, initially contacting a non-emergency health service/family doctor and delay in transport to the hospital. Regarding the pre-hospital phase for ATAADs, we report a median 'onset-to-presentation' time of 126.5 min or slightly more than 2 hours. As we live in a small country, transportation delay is assumed to be insignificant. A possible solution for reduction of this delay are educational campaigns to increase patient and bystander awareness. As ATAAD is still a very rare (but also very lethal) condition, which often mimics other medical emergencies like stroke or ACS, it is our believe that raising public awareness is very difficult. Evaluating the effect of such existing campaigns for stroke could not show a reduction in time to presentation (26).

A previous study reported on the delay from diagnosis to surgery in transferred ATAADs (16). They found a significant time delay in patients who were transferred and this was explained by the interhospital transfer time and a longer 'presentation-to-diagnosis' time at the referring hospital. In our series the median interhospital transfer time was 90 min or 1.5 hours. 'Presentation-to-diagnosis' time did not differ significantly between our institution and the referring hospitals in contrast to the results reported by Harris *et al.* (2) and Froehlich *et al.* (16). This could be explained by our small sample size and the insignificance of interhospital transfer time in our country.

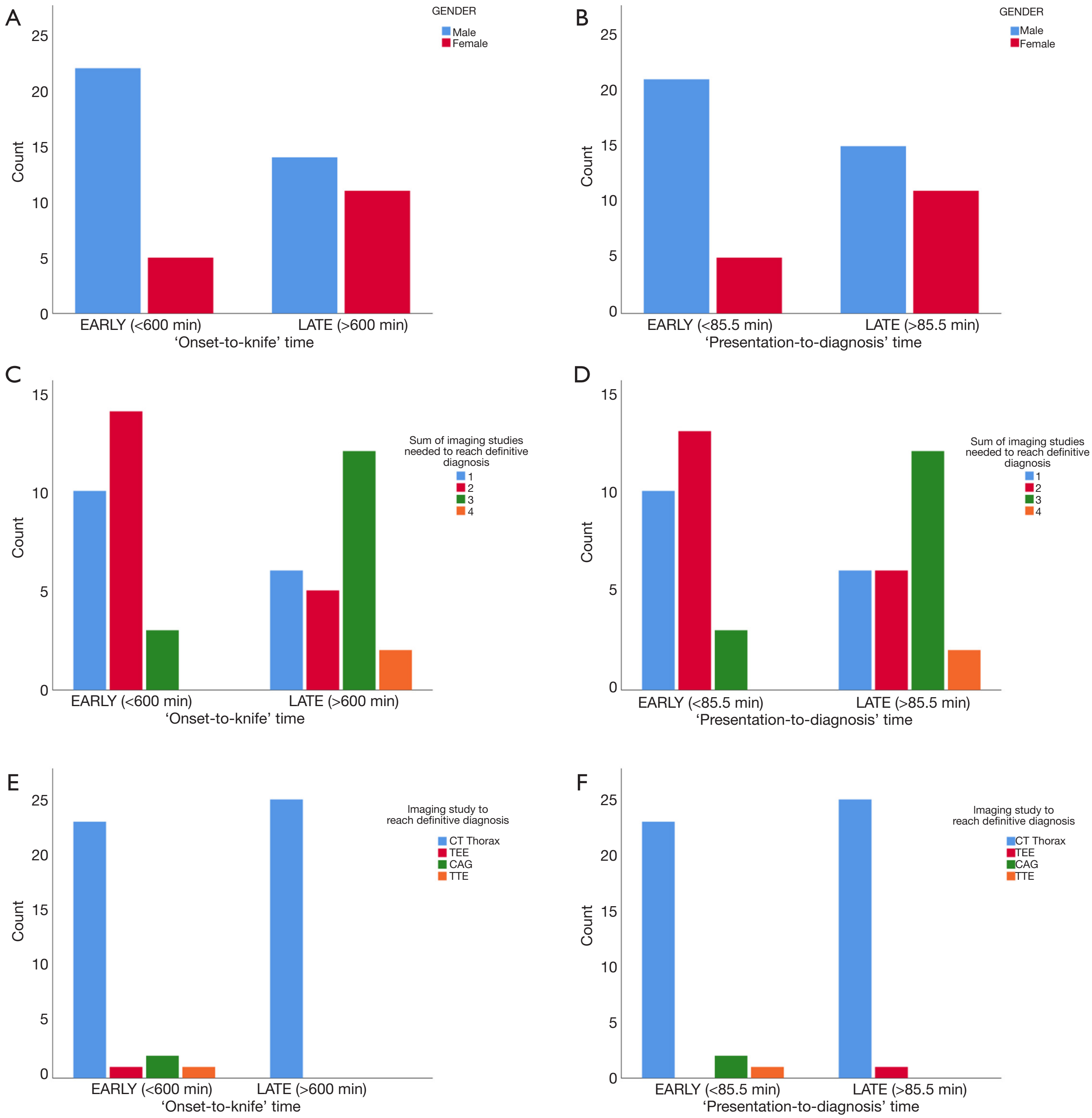

Figure 4 Factors influencing early or late diagnosis and/or treatment in patients presenting with acute type A aortic dissection. Gender, sum of imaging studies needed to reach definitive diagnosis and imaging study to reach definitive diagnosis. (A) Male gender has a significant higher chance at a short 'onset-to-knife' time (P=0.049). (B) The more imaging studies are requested/performed, the higher chance at a long 'onset-to knife' time (P=0.008). (C) Definitive diagnosis is nearly always reached after CT thorax, but transthoracic/transoesophageal echocardiography (TTE/TEE) or coronary angiography may lead to a shorter 'onset-to-knife' time (P=0.047). (D) The 'presentation-to-diagnosis' time is not significantly affected by gender. (E) The more imaging studies are requested/performed, the higher chance at a long 'presentation-to-diagnosis' time (P=0.008). (F) Definitive diagnosis is nearly always reached after CT thorax, but this does not significantly influence the 'presentation-to-diagnosis' time.

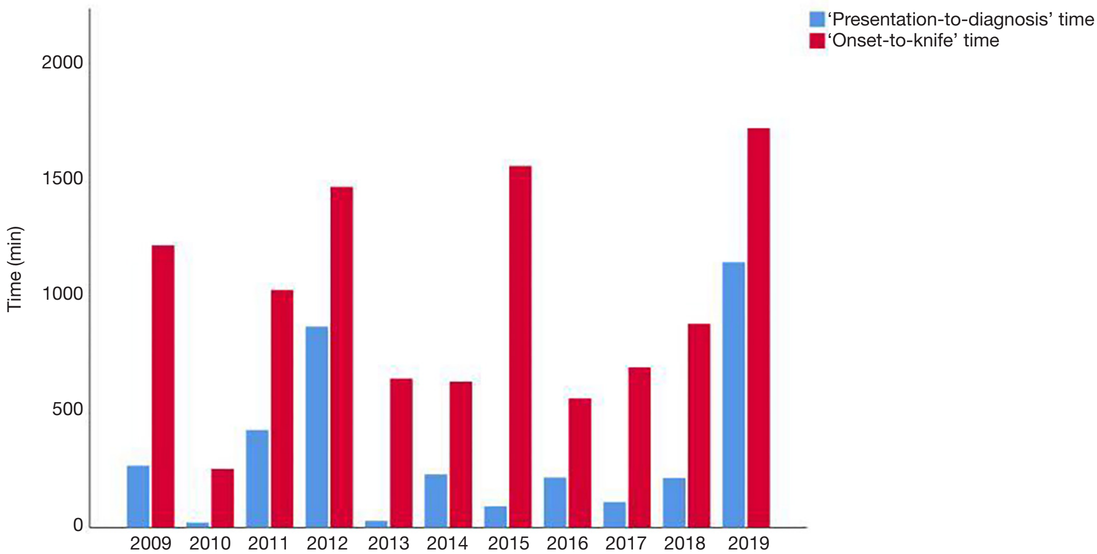

Figure 5 'Presentation-to-diagnosis' time and 'onset-to-knife' time over a 10-year period.

It is worth mentioning that in only 2 patients, the definitive diagnosis was not established at the referring hospital before transportation. One was referred because of cardiac tamponade and the other because of the initial diagnosis of an acute type B aortic dissection.

In-hospital delays depend on the initial interpretation of symptoms and the clinical response which includes ordering the appropriate diagnostic test in a timely manner. This is especially true when symptoms are insidious or mimic more common medical emergencies. In our series, the median 'presentation-to-diagnosis' time is 85.5 min or approximately 1.5 hours. Compared to the results of the IRAD (2) and Rapezzi *et al.* (18), which report a time delay of 4.3 hours and 5.5 hours respectively, our time delay seems shorter. Nevertheless, raising clinical awareness of the variety of initial symptomatology in ATAAD is important to reduce delays and by consequence improve patient outcome. Initial misdiagnosis and treatment of more common aetiologies like ACS (17) can lead to administration of antithrombotic agents with a consequently high risk of peri- and postoperative bleeding (27). Coronary angiography can be hazardous in ATAAD (14). However, it is worth mentioning that since the frequency of ACS greatly outnumber the number of dissections, it is appropriate for emergency physicians to focus on this diagnosis in patients presenting with chest or back pain (28,29). It has to be kept in mind that in many cases of ATAAD, electrocardiographic repolarization abnormalities and/or increased troponin levels do reflect coexistent myocardial ischemia with a multifactorial pathogenesis (17).

We analysed the initial symptoms and its influence on 'presentation-to-diagnosis' time and the 'onset-to-knife' time, but could not find a significant relation. This is in contrast to other literature reports, stating that patients experiencing severe symptoms like hypotension, shock and cardiac tamponade receive more swift diagnosis and treatment because of the life-threatening situation (2,16). Atypical presenting symptoms, initial suspicion of ACS or a pulmonary aetiology and presentation to a nontertiary care hospital all may contribute to a late diagnosis of ATAAD (2,15). Again, we attribute our results to the small sample size.

We did find that female patients have a higher chance to have a long 'onset-to-knife' time, which was also found in the IRAD (7). We have no unequivocal explanation for this recurring finding. However, it is known that cardiovascular disease in women is more often under-treated, less well studied compared to men and that they have a worse outcome. In addition, they often present with atypical complaints, which means a broader diagnostic landscape and a longer timeframe to find the correct diagnosis (30).

Although the main value of laboratory testing in ATAAD is exclusion of other diseases, D-dimer analysis should be part of the initial assessment of patients with suspected ATAAD and with chest pain in general (31). D-dimer testing has a reported sensitivity of almost 100% and a specificity of 68.8% (31). D-dimer concentration was determined in only 55.8%, there is room for improvement, especially because a negative result makes the presence of the disease unlikely.

Regarding imaging studies, definitive diagnosis was reached by computed tomography in 92.3%. In the long 'onset-to-knife' time we found a significant higher number of imaging studies performed before reaching definitive diagnosis. Although the computed tomography is reported as the preferred initial imaging modality (2), it is also known to delay the time to surgery (16). This statement explains our result that the definitive diagnosis was reached after performing computed tomography in all cases with a tardy 'onset-to-knife' time, whereas time can be saved by other, less time-consuming imaging studies like transthoracic echocardiography. This significant result is in contrast with the study by Strauss *et al.* (15), which report a lower incidence of computed tomography in the tardy 'onset-to-knife' time, with more time consuming alternative imaging studies like magnetic resonance. Transoesophageal echocardiography can more accurately confirm an ATAAD, but in our view, this should not delay surgery, as it can be done simultaneously in the operating room.

'Diagnosis-to-surgery' time at our institution is significantly longer than the other time-related variables, with a median time of 210 min or 3.5 hours, but not extremely different from the 4.3 hours reported by Harris *et al.* (2) As it is desirable to reduce this delay, an improvement in management with optimisation of organisation regarding operating room and personnel availability could be beneficial. There are reports on surgical delay to address malperfusion syndromes prior to surgery, by optimizing the flow in the true lumen, but most patients will benefit from immediate surgical treatment of the causative ATAAD (22).

Over time, we could not demonstrate a significant reduction in 'presentation-to-diagnosis' time or in 'onset-to-knife' time, which attributes to previous reports (4,13).

Despite the fact that this was not the purpose of the study, we report a 30-day mortality of 7.7% and an in-hospital mortality of 11.5% proving that also small-volume cardiothoracic centres can obtain excellent results. Nevertheless, there was no significant difference between short or long 'onset-to-knife' time or 'presentation-to-diagnosis' time. This was also reported by Strauss *et al.* (15).

Limitations

This retrospective analysis covers a very heterogenous population, presenting with an ATAAD and the numbers available from this single network study (even over a 10-year period) limited the statistical power greatly to explore possible determinants of (diagnostic) delay and precluded meaningful analysis of the impact on mortality. As a result, assuming a direct cause and effect relationship should be done with caution. This study only highlights those cases in which the diagnosis and treatment of ATAAD is established. It is unclear how many cases of aortic dissection were missed within our referral network.

Conclusions

This report reveals the need for an ever high index of suspicion regarding the capricious clinical presentation of ATAAD by emergency personnel and improvement in logistics regarding the 'diagnosis-to-surgery' time. Early admission to the hospital followed by sharp and accurate diagnosis is a prerequisite for successful intervention in ATAAD. Owing to the time-dependent properties of ATAAD management, a (national) system of aortic dissection care should be implemented.

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Footnote

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