Diagnosis of ruptured abdominal aortic aneurysm: a multi-centre cohort study

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SHORT TITLE

Diagnosis of ruptured AAA

ABSTRACT

Objective

The aim of this study was to describe the presentation of patients with ruptured abdominal aortic aneurysm (rAAA) and identify factors contributing to misdiagnosis.

Methods

An observational study of cases with a final diagnosis of rAAA assessed at nine Emergency Departments (EDs) and managed at one of two regional vascular centres in the United Kingdom.

Results

Eighty-five consecutive cases were included. Seventeen (20.0%, 95% CI 11.5-28.5%) patients reported important symptoms up to three weeks before index presentation. In the ED, most patients complained of abdominal and/or back pain, seven (8.2%, 95% CI 2.4-14.0%) additionally reported atypical pain, and ten (11.8%, 95% CI 4.9-18.7%) denied pain altogether. Hypotension (36.5%, 95% CI 26.3-46.7%), tachycardia (18.8%, 95% CI 10.5-27.1%) and syncope (36.5%, 95% CI 26.3-46.7%) were documented in a minority of cases. Distracting symptoms were present in 33 (38.8%, 95% CI 28.4-49.2%) patients. Median time to diagnosis was 17.5 minutes (range: immediate – 12 days), and twenty-one (25.6%, 95% CI 16.3-34.9%) patients were misdiagnosed during clinical assessment.

Conclusion

The classical signs and symptoms or rAAA are not always present and patients frequently exhibit additional features that may confound the diagnosis. A low index of suspicion should be adopted for rAAA alongside a low threshold for immediate computed tomography. Further research is required to develop an objective clinical risk score or predictive tool for characterizing patients at risk.

INTRODUCTION

The prevalence of abdominal aortic aneurysm (AAA) in European men aged >65 is around 1.5% [1] [2]. Although operative mortality may be as low as 37% [3], it is likely that many patients die before reaching definitive surgical intervention. Randomised trials (IMPROVE and AJAX) have not shown a definitive benefit to endovascular as opposed to open surgical strategy[4] [5] [6] but have demonstrated the importance of logistics for patients with ruptured AAA (rAAA) including efficient out-of-hours working, the threshold for permissive hypotension[7], the availability of endovascular aneurysm repair (EVAR) under local anaesthesia, and efficient identification and transport of cases with rAAA to specialist centres[8].

The clinical presentation of rAAA is classically described as a triad of abdominal and/or back pain, hypotension, and an expansile abdominal mass [9]. However, patients with rAAA may also present atypically with isolated symptoms commonly encountered in the Emergency Department (ED), e.g. lower back pain or syncope [10]. An expansile abdominal mass is frequently not detected, with one analysis of pooled datasets suggesting that the positive predictive value of clinical examination for identifying AAAs was only 43% [11]. One study of 243 patients with known AAAs found that only 23% were palpable, even when the assessing clinician knew the diagnosis[12]. AAAs are particularly less likely to be detected on clinical examination in obese patients[13]. Atypical rAAA presentations reported in the published literature include transient lower limb paralysis [14] [15], unilateral leg swelling [16], testicular ecchymosis [17] [18], iliofemoral venous thrombosis [19], inguinoscrotal mass [20], phlegmasia cerulea dolens (lower limb pain, swelling, and cyanosis) [21], and even obstructive jaundice [22]. The infrequent and varied presentation of rAAA may lead to misdiagnosis in between 16% and 62% of cases [23] [24] [25] [26] [27] [28]. Misdiagnosis of rAAA might contribute to treatment delay or influence operative survival, and more research is required to describe the factors associated with accurate clinical diagnosis of this surgical emergency. Data from the AJAX Trial (Amsterdam Acute Aneurysm Trial) suggest that improvement of rAAA logistics, including centralization and pre-operative planning, are key to optimizing outcomes[4].

This two-network retrospective observational study aimed to describe the spectrum of rAAA presentation in the United Kingdom and to identify factors contributing to misdiagnosis.

METHODS

Setting

Cases were identified from two UK regional vascular centres that received transfers from seven general hospitals as well as referrals through their own EDs. The two vascular centres were the University Hospital Coventry & Warwickshire (UHCW) in Coventry and St George's Hospital in London. UHCW has 1,116 beds[29] and acts as the vascular hub for Warwick Hospital (Warwick) and the George Eliot Hospital (Nuneaton). St George's Hospital has 914 beds[29] and provides vascular services for Kingston Hospital (Surrey), Croydon University Hospital (Croydon), St Helier Hospital (Carshalton), and East Surrey Hospital (Redhill). Both vascular centres had CT scanning facilities within their EDs during the study period.

Case selection

Inclusion criteria were any patient assessed between 1st December 2011 and 31st June 2012 and coded at discharge with a primary ICD-10 diagnosis of I71.3 ("abdominal aortic aneurysm, ruptured"). Final diagnosis was based on radiological imaging, intra-operative and/or post-mortem findings. Data were extracted and recorded onto a structured proforma from case notes, imaging software, and electronic patient records. Extracted fields included demographic details (age, sex, known AAA), signs and symptoms (pain distribution, vital signs, palpable AAA), mode of transport, details of index and subsequent clinical assessments (time, grade and specialty of doctor, investigations requested, provisional diagnosis), and outcomes (peri-operative mortality, in-hospital mortality, 30-day and 60-day mortality).

Data extraction

ED notes from both the initial presenting hospital and the vascular referral centre were accessed for all patients. A small pilot sample was used to design a standard proforma that recorded details that were consistently available for most cases in the cohort. Three authors (DM, KS, ST) then independently extracted data onto a standard proforma and disagreements were resolved through discussion.

Definitions

Patients had a "known AAA" if an AAA had been previously identified (e.g. incidentally or on screening), whether or not this was apparent to the assessing clinician. "Altered consciousness" was defined as a recent history of syncope or reduced Glasgow Coma Score (GCS). Hypotension was defined as systolic blood pressure ≤90mmHg (as this commonly used as the threshold for cardiovascular "shock"[30]) and tachycardia as a heart rate ≥100 beats per minute. Body Mass Index (BMI) was calculated using height and weight from recent hospital episodes or from observations recorded on the ward in the day immediately following surgery. A palpable AAA was assumed to be present if documented following clinical examination by a clinician of any grade or specialty.

The "first clinician" was defined as the doctor conducting a full clinical assessment of the patient at index presentation, in most cases the ED doctor. Brief triage assessments by nursing staff or paramedics were excluded. The diagnosis of rAAA was reached when documented either as the primary diagnosis or as a differential to be excluded, e.g. with ultrasound or CT scanning. In the binary logistic regression equations, cardiovascular instability was defined as hypotension and/or tachycardia and/or loss of consciousness, and non-specialist clinician as anyone not occupying a consultant or senior training grade (e.g. registrar) in vascular surgery or emergency medicine.

Statistical analysis

Continuous data were described as a mean with standard deviation and 95% confidence intervals if normally distributed and otherwise as a median with range and interquartile ranges (IQR). Missing data was managed by pairwise deletion. Binary logistic regression models were created to predict correct initial diagnosis. Backward selection was employed and inclusion in the final model required a significance level of $\alpha = 0.1$. Significant results were reported at $\alpha=0.05$. All statistical analyses were performed using SPSS v22 (IBM Corp, Armonk, NY).

RESULTS

Eighty-five patients were identified as having a rAAA during the study period. The median age was 76.0 years (range 60.0-97.0, IQR 13.0), the majority of patients (82.4%, 95% CI 74.3-90.5%) were male, and the median BMI was 27.0 kg/m^2 (range 18.0-37.0, IQR 5.8).

All case notes included a history, examination findings, vital signs, provisional diagnosis, and management plan. It was possible to follow-up all patients using discharge summaries, medical notes, and bereavement office records.

Presentation

Seventeen (20.0%, 95% CI 11.5-28.5%) patients explicitly reported symptoms potentially attributable to AAA ≥1 day before their index presentation, which are represented by Figure 1. Symptom duration ranged from one day to three weeks (mean five days) with five patients seeking medical attention during this time. Four saw their general practitioner and one presented to both an ED and a fracture clinic after injuring their ankle during an unwitnessed collapse. In this group, five patients (29.4%, 95% CI 19.7-39.1%) had a previously diagnosed AAA.

At ultimate presentation to the ED, fifty-two patients (61.2%, 95% CI 50.8-71.6%) complained of abdominal pain, 46 (54.1%, 95% CI 43.5-64.7%) back pain, ten (11.8%, 95% CI 4.9-18.7%) groin pain, and four (4.7%, 95% CI 0.2-9.2%) loin pain. The combination of abdominal and back pain was only reported in 25 (29.4%, 95% CI 19.7-39.1%) cases. Although seven patients (8.2%, 95% CI 2.4-14.0%) complained of atypically distributed pain (Figure 2) none complained of atypically distributed pain in isolation – all had abdominal and/or back pain in addition. Ten patients (11.8%, 95% CI 4.9-18.7%) denied having any pain at all. Although these patients were all able to communicate during clinical assessment, seven (70.0%, 95% CI 41.6-98.4%) had a recent history of syncope and/or loss of consciousness (LOC) in the ED, which was much higher than the equivalent proportion in those reporting pain (32.0%, 95% CI 21.4-42.6%, Fisher's Exact Test p = 0.005). Only 21% (95% CI 12.3-29.7%) presented with the complete triad of back or abdominal pain, hypotension, and a palpable mass.

LOC was recorded in 31 (36.5%, 95% CI 26.3-46.7%) cases and did not feature at any stage in 54 (63.5%, 95% CI 53.3-73.7) cases. Hypotension was present in 32 (37.6%, 95% CI 27.3-47.9%) cases and absent in 53 (62.4%, 95% CI 52.1-72.7%) cases. Similarly, only 16 (18.8%, 95% CI 10.5-27.1%) patients were tachycardic with 69 (81.2%, 95% CI 72.9-89.5%) patients maintaining a normal heart rate. In total, 30

patients (35.3%, 95% CI 25.1-45.5%) exhibited no features of cardiovascular instability (tachycardia, hypotension, or LOC) at any stage.

Potentially distracting symptoms were present in 33 (38.8%, 95% CI 28.4-49.2%) cases. Fifteen (17.6%, 95% CI 9.5-25.7%) had gastrointestinal symptoms that risked directing clinicians erroneously towards an alternative cause for abdominal/back pain. These symptoms are shown in Figure 3. A palpable AAA was documented in 56 (70.0%, 95% CI 60.3-79.8%) cases.

Diagnosis

The median time to diagnosis from arrival in the ED was 17.5 minutes (range zero minutes to twelve days, IQR 126 minutes). Twenty-one (25.6%, 95% CI 16.3-34.9%) cases were not initially recognized as rAAA by the first clinician conducting a full assessment. Alternative provisional diagnoses included diverticulitis, renal colic, non-specific abdominal pain, appendicitis, intestinal obstruction, testicular torsion, pancreatitis, pneumonia, upper gastrointestinal bleed, vasovagal collapse, urinary tract infection, and sepsis of unknown source. Diverticulitis and renal colic each featured twice as misdiagnoses.

In univariate analyses, the likelihood of the first assessing clinician accurately diagnosing rAAA was not significantly associated with collapse (p = 0.203), cardiovascular instability (p = 0.998) or known AAA (p = 0.388). Similarly, no particular distribution of pain (e.g. back pain) was significantly associated with achieving a correct initial diagnosis. The presence of a palpable AAA was associated with the correct initial diagnosis (p = 0.037). A logistic regression analysis demonstrated that only the presence of a palpable AAA (OR 3.3, 95% CI 1.1-9.4, p = 0.029) and collapse (OR 3.2, 95% CI 1.0 – 10.0, p = 0.042) were independent predictors of the correct diagnosis of rAAA being reached by the first assessor.

DISCUSSION

This study confirms previous findings that rAAA is commonly misdiagnosed across a range of settings [23] [24] [25] [26] [27] [28]. rAAAs were mistaken for twelve different diseases in this series. Over a quarter of cases were initially misdiagnosed and one patient was admitted with an incorrect diagnosis

for twelve days. However, this level of misdiagnosis is comparable to ED data from the United States where 30% of rAAA patients are not recognized on initial assessment [24].

A small subgroup (20%, 95% CI 11.5-28.5%) had symptoms potentially attributable to AAA in the days before their index presentation. The only other study to report interval between symptom onset and presentation suggested that 43% of rAAA patients develop potentially relevant features ≥9 hours before admission [26]. Although clinicians are taught that rAAA presents as a triad of abdominal/back pain with hypotension and an expansile abdominal mass [9], this study showed that many rAAAs presented non-classically. In our study, the only variables associated with correct eventual diagnosis were collapse on admission, or the presence of a palpable AAA. Importantly, 38.8% (95% CI 28.4-49.2%) exhibited additional features that potentially confounded the diagnosis. These varied clinical presentations are a feature of rAAA pathoanatomy. Misdiagnosis can often arise from the variable compressive effect of a retroperitoneal haematoma. For example, testicular pain might be caused by compression of the ilioinguinal and/or genitofemoral nerves [31]. Although some patients reported no pain, this group had a significantly higher rate of LOC than those with pain (70.0% v. 32.0%, Fisher's exact test p = 0.005), which raises the possibility of cognitive impairment caused by hypovolaemic compromise in this group. Other potentially distracting symptoms (e.g. vomiting and hyperventilation) were also consistent with haemodynamic shock. This complex clinical picture is particularly important in the context of the recent IMPROVE trial which showed that most rAAAs initially present to non-vascular centres (60.3%) and outside of normal working hours (64.9%) [6]. These findings suggest that most rAAAs will first be assessed by a relatively inexperienced clinician in a non-specialist centre.

No significant association was demonstrated between initial misdiagnosis and patient mortality. Despite this potentially being due to a limited cohort size, the finding is consistent with other retrospective series from the United States [24] and Europe [26]. Selection bias may underlie this observation because rAAA becomes more obvious in deteriorating patients, leading to the selection of more stable patients for retrospective in-hospital studies. This is a particular limitation of our study because patients that died in peripheral hospitals (some presumably undiagnosed) would not have been transferred to a specialist centre and so are absent from our cohort. Although markers of cardiovascular instability (tachycardia and hypotension) did not influence diagnosis in our series, others have shown that

haemodynamically stable rAAAs are less likely to be recognized promptly [23]. It is likely that prompt diagnosis and intervention could improve outcomes across the population of patients with rAAA.

The demographic profile of patients in this series is consistent with risk factors identified elsewhere [10] [6]. Although smoking status and family history were not routinely documented, 82.4% (95% CI 74.3-90.5%) of patients were males aged over 60 years. In addition, our study found a greater prevalence of palpable AAAs (70%, 95% CI 60.3-79.7%) than has previously been reported [11]. These findings emphasize that AAA should be considered in all older males presenting acutely with a wide range of symptoms, from hip pain to melaena. The frequency with which bedside ultrasound is used to identify AAAs might be increased by greater involvement of trained ED doctors in this non-invasive and readily available imaging technique. However, the critical conclusion is that emergency departments should adopt a low threshold for immediate computed tomography, which remains the gold standard for the diagnosis of rAAA.

Conclusion

rAAA is a frequently fatal surgical emergency that results in mortality if it is missed or misdiagnosed. This multi-centre retrospective cohort study confirmed that the cardinal triad of features was only reported by a minority (21%, 95% CI 12.3-29.7%) of patients presenting with rAAA. Clinicians should therefore adopt a low threshold of suspicion for rAAA and urgent diagnostic imaging. Further research is necessary to characterize the relationship between misdiagnosis and patient outcomes, and to develop an objective clinical risk score for improving the diagnosis of this important emergency.

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LEGENDS

Figure 1: A bar chart showing the number of cases presenting with features likely attributable to a rAAA ≥1 day before final presentation. Hatched lines indicate the proportion of patients in each group that were previously known to have a AAA.

Figure 2: A bar chart showing the number of cases without pain or pain in an atypical distribution.

Figure 3: A bar chart showing the frequency with which patients complained of features that might indicate a non-rAAA cause for their presentation.