ORIGINAL ARTICLE

Anticoagulant-related abdominal hematomas: Clinical and CT findings

Antikoagülana bağlı abdominal hematomların klinik ve BT bulguları

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Background and Aims: *We aimed to evaluate clinical features and computed tomography findings of anticoagulant-related abdominal hematomas.* ***Material and Methods:*** *We conducted a retrospective systematic study of 55 patients (mean age, 66±12 years; range, 29-84 years) on anticoagulant therapy and diagnosed with abdominal hematoma between March 2008 and May 2016. Patients data were evaluated for demographic characteristics, clinical manifestations, medical history, associated factors, biochemical tests, computed tomography findings, treatment, and outcomes.* ***Results:*** *The most commonly used anticoagulant agent was warfarin (72.7%), followed by enoxaparin (20%) and both warfarin and enoxaparin (7.3%). The main clinical symptoms were abdominal pain and distention. Among the total 85 locations of hematomas, the most frequent locations were the rectus muscle sheath (50.9%) and gastrointestinal tract (30.9%). According to the Control Anticoagulation Committee criterion, 15 (27.3%) patients had major hemorrhages.* ***Conclusion:*** *Prompt and accurate diagnoses can be made through better understanding the most common clinical and computed tomography findings regarding anticoagulant-related abdominal hematomas. In addition, this has a direct impact on clinical management.*

Key words: *Abdominal hematoma, anticoagulant therapy, computed tomography*

Giriş ve Amaç: *Antikoagülan ilişkili abdominal hematomların klinik özelliklerini ve bilgisayarlı tomografi bulgularını değerlendirmeyi amaçladık.* ***Gereç ve Yöntem:*** *Bu sistematik retrospektif çalışmaya Mart 2008 ile Mayıs 2016 tarihleri arasında antikoagülan tedavi altında abdominal hematom tanısı alan 55 hasta (ortalama yaş: 66±12 yıl, aralık 29-84) dahil edildi. Hastalar; demografik özellikler, klinik belirtiler, tıbbi öykü, ilişkili faktörler, biyokimyasal testler, bilgisayarlı tomografi bulguları, tedavi ve sonuçları açısından değerlendirildi.* ***Bulgular:*** *En sık kullanılan antikoagülan ajan warfarin (%72.7) olmakla birlikte enoksaparin kullanımı %20 ve warfarinin enoksaparin ile birlikte kullanımı %7.3 oranlarında saptandı. Ana klinik semptomlar karın ağrısı ve abdominal distansiyondu. Toplam 85 hematom alanı saptandı ve en sık görülen lokalizasyonlar rektus kas kılıfı (%50.9) ve gastrointestinal sistem (%30.9) olarak izlendi. Kontrol Antikoagülasyon Komitesinin kriterlerine göre 15 (%27.3) hastada majör kanama saptandı.* ***Sonuç:*** *Antikoagülan ilişkili abdominal hematomların sık görülen klinik ve bilgisayarlı tomografi bulgularının bilinmesi, hızlı ve doğru tanı koymayı olanak sağlar. Aynı zamanda klinik hasta yönetiminde doğrudan bir etkiye sahiptir.*

Anahtar kelimeler: *Abdominal hematom, antikoagülan tedavi, bilgisayarlı tomografi*

INTRODUCTION

Anticoagulant therapy is the mainstay of treatment and prevention of thrombosis in many clinical conditions, including ischemic cerebral vascular disease, prosthetic heart valves, acute venous thromboembolism, atrial fibrillation (AF), and acute coronary syndrome, and in patients undergoing invasive cardiac procedure (1).

Hemorrhage or spontaneous hemorrhage is the primary complication of anticoagulant therapy and is a risk of all agents, even when maintained within usual therapeutic or normal ranges. Major determinants of hemorrhages are the intensity of the anti-clotting effect, underlying patient characteristics, and the length of therapy (2,3). The clinical presentation varies depending on the location and severity of the hemorrhage. Further, the diagnosis is based on the patient's clinical history, physical examination, laboratory results, and imaging findings (4,5).

In this study, we aimed to evaluate associated factors, clinical manifestations, and computed tomography (CT) findings in patients with anticoagulant-related abdominal hematomas within the literature.

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MATERIALS and METHODS

We retrospectively reviewed medical records of 55 patients who were diagnosed with an abdominal hematoma from March 2008 to May 2016. Data regarding patient demographics are shown in Table 1. The following inclusion criteria were applied for study participation: 1) Use of any anticoagulant agent and 2) Presence of CT

Table 1. Baseline study characteristics

Total Number of Patients-*N*	**55**
Age-year, *mean±standard deviation, (range)*	**66±12 (29-84)**
Gender-*n (%)*	
Female	38 (69.1)
Male	17 (30.9)
Indications for anticoagulation-*n (%)*	
Atrial fibrillation	22 (40)
Mitral valve replacement	17 (30.9)
Coronary artery disease	5 (9.1)
Cerebrovascular disease	5 (9.1)
Pulmonary thromboembolism prophylaxis	4 (7.3)
Peripheric artery disease	4 (7.3)
Pulmonary thromboembolism treatment	2 (3.6)
Associated clinical co-morbidities-*n (%)*	
Hypertension	28 (50.9)
Congestive heart failure	14 (25.5)
Diabetes mellitus	10 (18.2)
Stroke/transient ischemic attack	10 (18.2)
Coronary artery disease	9 (16.4)
Surgery	6 (10.9)
Chronic kidney disease	5 (9.1)
Malignancy	5 (9.1)
Chronic obstructive lung disease	2 (3.6)
Presenting symptoms/findings-*n (%)*	
Abdominal pain	55 (100)
Abdominal distention	38 (69.1)
Abdominal swelling	13 (23.6)
Ecchymosis	9 (16.4)
Extremity mobility limitation	2 (3.6)
Nausea and vomiting	1 (1.8)
Hematemesis	1 (1.8)
Melena	1 (1.8)
Hematuria	1 (1.8)
Anticoagulants-*n (%)*	
Warfarin	40 (72.7)
Enoxaparin	11 (20)
Warfarin+Enoxaparin	4 (7.3)
Co-administration with antiplatelet agents-*n (%)*	**10 (18.2)**
Warfarin+ASA	3 (5.5)
Enoxaparin+ASA	5 (10.2)
Warfarin+Enoxaparin+ASA	1 (1.8)
Warfarin+ASA+Clopidogrel	1 (1.8)

ASA: Acetylsalicylic acid.

examination for hematoma upon acute presentation. Patients with a recent history of trauma or surgery were excluded. Among eligible cases, medical charts were reviewed to obtain data regarding demographic characteristics, presenting symptoms/findings, medical history, medications and dosages, associated co-morbidities, complete blood count and coagulation tests, biochemical profiles as well as CT findings and outcomes. Some patients had multiple indications, associated co-morbidities, and data on hemorrhage location. CT was performed with or without contrast using 2-, 8-, and 64- slice CT scanners (Somatom Spirit; Siemens, Erlangen, Germany; Light Speed Ultra; GE, Milwaukee, USA; Aquilion 64; Toshiba Medical Systems, Otawara, Japan). Upon CT examination, the number and location of hematomas and extension of hemorrhage were studied. In addition, we evaluated the presence of hematocrit effect, defined as a blood plasma level most frequently observed with anticoagulant-related hematomas. Hematomas were classified as major or minor on a clinical and imaging basis using the Control of Anticoagulation Subcommittee criterion.

Statistical analyses were performed using IBM SPSS Statistics software, version 20.0 (SPSS Inc, Chicago, IL, USA). Continuous and categorical variables were expressed as medians (minimum–maximum) and number (percentage), respectively. Distributions of continuous variables were determined using the Kolmogorov–Smirnov test.

We obtained approval from the ethics board for non-pharmacological clinical trials.

RESULTS

All participants in this study were adults (mean age: 66±12 years, range 29-84 years). There were 38 females (69.1%) and 17 males (30.9%). AF (40%) and mitral valve replacement (MVR; 30.9%) were the most common indications of anticoagulation. Other indications included coronary artery disease, cerebrovascular disease, pulmonary thromboembolism (PTE) prophylaxis, PTE treatment, and peripheric arterial disease. The most commonly associated co-morbidities were hypertension (50.9%), congestive heart failure (25.5%), diabetes mellitus (18.2%), stroke or transient ischemic attack (18.2%), coronary artery disease (16.4%), surgery (10.9%), chronic renal failure (9.1%), and malignancy (9.1%). The most commonly presenting symptoms were abdominal pain (100%), abdominal distention (69.1%), abdominal swelling (23.6%), and skin ecchymosis (16.4%). Abdominal distention and pain (69.1%) was the most common combination of presenting symptoms (Table 1).

Warfarin was the most prescribed single anticoagulant agent (72.7%), followed by enoxaparin as low-molecu-

Table 2. Blood test results

International normalized ratio	**2.57 (0.90-16.19)**
Warfarin users	2.91 (0.90-16.19)
Increased international normalized ratio-n (%)	47 (85.5)
Prothrombin time-*s*	**28 (11-113)**
Increased prothrombin time-n (%)	44 (63.6)
Activated partial thromboplastin time-*s*	**47 (15-141)**
Increased activated partial thromboplastin time-n (%)	40 (72.7)
Hemoglobin-*g/dL*	**10.1±2.6**
Decreased hemoglobin-n *(%)*	32 (58.2)
Hematocrit-%	**31.5±7.4**
Decreased hematocrit-n *(%)*	40 (72.7)
Platelets-10^3/*μL*	**250±91**
Decreased platelets-n (%)	9 (16.4)
Glucose-mg/dL	**125 (78-280)**
Increased glucose-n (%)	24 (43.6)
Blood urea nitrogen-*mg/dL*	**31 (8-115)**
Increased blood urea nitrogen	23 (41.8)
Creatinine-*mg/dL*	**1.05 (0.60-7.05)**
Increased creatinine-n (%)	32 (58.2)

Continuous variables are presented as median (minimum–maximum) or mean±standard deviation)

lar-weight heparins (LMWH) (20%) and both warfarin and enoxaparin (7.3%). Ten (18.2%) patients underwent anticoagulant and antiplatelet therapy [acetylsalicylic acid (ASA) or clopidogrel]. The most common drug combination was enoxaparin and ASA (10.2%; Table 1).

Overall, the median international normalized ratio (INR) level was 2.57 (min: 0.90; max: 16.19). In patients on warfarin, the median INR level was 2.91 (min: 0.90; max: 16.19). Of these, 20 (36.4%) and 10 (18.2%) patients had an INR level of >5 and >10, respectively. INR values were normal in 8 (14.5%) and high in 47 (85.5%) patients. Within the study population, the mean hemoglobin (Hb) and platelet counts were 10.1±2.6 g/dL and 250±91 103/μL; blood test results are shown in Table 2.

Table 3. CT findings of abdominal hematomas and outcomes

Total Number of Patients-*N*	**55**
Location of Hematomas-*n (%)*	
Abdominal muscles	
Left rectus sheath	18 (32.7)
Right rectus sheath	16 (29.1)
Left iliopsoas	6 (10.9)
Right iliopsoas	2 (3.6)
Pectineus	1 (1.8)
Quadratus lumborum	1 (1.8)
Gastrointestinal tract	
Ileum	9 (16.4)
Jejunum	7 (12.7)
Duodenum	4 (7.3)
Colon	2 (3.6)
Gastric	1 (1.8)
Rectum	1 (1.8)
Retroperitoneal	7 (12.7)
Intraperitoneal	2 (3.6)
Renal	
Right suburothelial	2 (3.6)
Left perinephric	2 (3.6)
Left suburothelial	1 (1.8)
Ovary	**1 (1.8)**
Adrenal	
Left	1 (1.8)
Right	1 (1.8)
One location	34 (61.8)
Two locations	14 (25.5)
Three locations	6 (10.9)
Five locations	1 (1.8)
Total number of hematoma locations-*n*	**85**
Number of hematoma locations-mean±standard deviation	1.5±0.8
Hematocrit effect-*n (%)*	25 (21.3)
Severity of hemorrhage-*n (%)*	
Major hemorrhage	15 (27.3)
Minor hemorrhage	40 (72.7)
Outcomes-*n (%)*	
Alive	7 (12.7)
Exitus	48 (87.3)

In all patients, 85 location of hematomas were evaluated by CT. The rectus sheath muscle (50.9%) was the most common location of hematoma (left: 32.7%, right: 29.1%, and bilateral 10.9%). Rectus sheath hematomas (RSH) occurred more commonly infraumbilically [94.1% of RSH (n = 34)] and unilaterally [78.6% of patients (n=28) with RSH] and were more frequent in female patients (85.7% of patients with RSH). Using the CT classification by Berna´ et al, of the 34 RSHs occurring infraumbilically, 8 (23.5%) were grouped as type I, 11 (32.4%) were type II, and 15 (44.1%) were type III; the hematocrit effect was observed in 19 (55.9%) cases. The iliopsoas muscle was the second most common location of abdominal muscle hematomas (left: 10.9%; right: 3.6%). One patient had a pectineous and one patient had a quadratus lumborum muscle hematoma. The second most frequent location of abdominal hematomas was the gastrointestinal tract (30.9%). The most common location of intramural gastrointestinal tract hematomas (GITH) was the ileum (16.4%), followed by the jejunum (12.7%). The remaining hematoma locations were retroperitoneal (12.7%), intraperitoneal (3.6%), renal (9.1%), ovarian (1.8%), and adrenal (3.6%). Of the 5 renal hematomas, three were located suburothelially and 2 were located perinephrically. Multiple hematomas were present in 21 (38.2%) patients. Of these, 14 (25.5%), 6 (10.9%), and 1 (1.8%) patient had two, three, and five different hematomas, respectively. The mean number of hematomas was 1.5±0.8. The hematocrit effect was observed in parenchymal organs or muscles, not in luminal organs. The effect was observed in 20 (36.4%) patients and 25 (21.3%) of all abdominal hematomas; 16 (29%) patients were on warfarin and 4 (7.3%) were on enoxaparin (Table 3). Contrast extravasation was not observed in any case.

Overall, 15 (27.3%) patients had a major hemorrhage. Among those with major hemorrhages, surgery was performed in 3 (5.5%) patients because of uncontrolled bleeding, despite intense conservative therapy. Two patients with major hemorrhages died postoperatively because of the hemorrhage. Other patients were treated conservatively. During the follow-up, 1 patient developed abdominal compartment syndrome (ACS); in total, 7 (12.7%) patients died and 48 (87.3%) patients were still alive. Death resulting from hemorrhage occurred in only 2 patients (Table 3).

DISCUSSION

Anticoagulant drugs are currently prescribed and used for treating and preventing thromboembolic diseases. Classically used anticoagulant drugs are unfractioned heparin and warfarin, and newer drugs include LMWHs (such as enoxaparin), heparinoids, specific factor Xa inhibitors (such as fondaparinux), and direct thrombin inhibitors (such as lepirudin and argatroban). In addition, many agents are under development (1,3). Recently, a few cases of spontaneous hematomas have been reported under anticoagulant therapy involving new agents, such as fondaparinux and rivaroxaban (6,7). A major complication of anticoagulant treatment is hemorrhage, which occurs frequently among elderly patients. The most common locations of anticoagulant-related hematomas are the soft tissues, gastrointestinal tract, and urinary tract. In addition, many studies have found that female sex is a risk factor for anticoagulant-related hemorrhage (4). Epidemiological data observed in our study were similar to those of previous studies regarding increased hemorrhage frequency in elderly women.

Common risk factors for hemorrhages are advanced age, concurrent medication use, co-morbid diseases (including hypertension, diabetes mellitus, cardiac disease, liver dysfunction, renal insufficiency cerebrovascular disease, and long-term hemodialysis) as well as treatment duration and anticoagulant effect intensity (2,4,8). In this study, hypertension and cardiac problems were the most associated co-morbidities. A combination of antiplatelet and anticoagulant therapies has led to an increase in the incidence of hematomas (9). A recent study has reported on the association of concomitant antiplatelet agent use and a higher frequency of hemorrhage in patients treated with LMWHs (3). Similarly, majority patients (60%) undergoing a combination of antiplatelet and anticoagulant therapies were also receiving LMWH as an anticoagulant agent in the study. A few cases have been reported of antiplatelet therapy complicated with abdominal hematomas in the literature (10). Our study focused on anticoagulant-related hematomas; 4 patients were excluded from our study because of undergoing only antiplatelet therapy.

Clinical presentations may vary greatly depending on the size, location, and severity of the hemorrhage. An abdominal hemorrhage typically presents with sudden abdominal pain and distention associated with an acute decrease in hematocrit levels. Alternatively, less common presentations vary from skin ecchymosis around the umbilicus and flanks to life-threatening conditions, such as ACS or fatal hypovolemic shock (5). Our data confirms previous observations in which the most frequently presenting symptoms are abdominal pain and distention. Criteria used for defining the severity of hemorrhages

considerably varied between the studies. In non-surgical patients, the Control of Anticoagulation Subcommittee has recommended following criteria for major hemorrhage: fatal and/or symptomatic hemorrhages in a critical area or organ, such as intracranial, intraocular, intraspinal, retroperitoneal, intra-articular or pericardial, or intramuscular with compartment syndrome; hemorrhage causing a reduction in the hemoglobin level of ≥2 g/dl; or hemorrhage leading to transfusion of ≥two units of whole blood. Minor hemorrhages are defined as all hemorrhages other than those with life-threatening complications, such as hematuria, hemoptysis, epistaxis, and intramuscular hematoma (11).

Many studies have demonstrated an exponential increase in hemorrhagic events as INR increases to >5 (12). In this study, hemorrhages developed in 14.5% patients within normal INR ranges and in 85.5% patients within high INR ranges. Of these, majority patients (36.4%) had an INR level of >5.

A recent study has reported that increased glucose levels in cases of spontaneous intracerebral hemorrhage might be related to altered glucose metabolism caused by inflammatory cell activation (13). Similarly, in this study, increased glucose levels were detected in 43.6% patients with spontaneous abdominal hematomas, which may be associated with inflammatory processes.

Few studies assessing the risk of bleeding with anticoagulant therapy reported that the risk of bleeding is relatively increased among patients with reduced kidney function (14). We observed increased blood urea nitrogen and serum creatinine levels in 41.8% and 58.2% patients, respectively. This may indicate an association between hemorrhages and reduced kidney function.

The most common locations of hematomas are the body wall, retroperitoneum or extremity, peritoneal and pleural cavity, and subcapsular intraparenchymal locations. CT may be an accurate and prompt imaging technique for detecting, diagnosing, quantifying, and monitoring hematomas (15). Presentations of abdominal hemorrhage may be equivocal; further, Hb and hematocrit levels that are obtained acutely may not be reflective of the true extent of the hemorrhage. As such, CT is an effective method for detecting abdominal hemorrhages (5). Unenhanced CT can be used as an initial technique for detecting hemorrhages. Although unenhanced CT may mask the hematomas by isoattenuating the surrounding tissues, contrast-enhanced CT may be helpful in detecting contrast extravasation as a sign of an active hemorrhage. Hematomas have characteristic imaging features. Time-related features include contrast-material extravasation, presence of a fluid-cellular level (the hematocrit effect), hyperdensity, inhomogeneity, lucent halo, pseudocapsule, dense rim, calcifications, changes in size and attenuation, and thickening of fascial planes. Over time, hematomas decrease in size, attenuate, and may calcify later. Adjacent fascial plane thickening is a frequent, but non-specific, finding and is caused by fibrosis of hematomas. Inhomogeneity with isolated areas of hyperdensity is a frequent and relatively specific finding of anticoagulation. The fluid-cellular level resulting from the hematocrit effect is a linear separation of cellular and liquid components of the blood, and layering in the dependent position of the hematoma. A highly sensitive and specific sign of an anticoagulant-related hemorrhage is CT finding of the hematocrit effect, i.e., fluid-cellular levels with hyperdensity (5,15,16). In luminal organs, characteristic CT findings are concentric mural thickening, intramural hyperdensity on acute phase, luminal narrowing, obstruction, and dilated segments (17,18). In addition, CT angiography plays an essential role in the management of severe hematomas by identifying the location of the vascular source of bleeding (19). Based on the CT findings of the present study, the hematocrit effect was particularly observed in soft tissues and not in luminal organs. In this study, 21.3% of all hematomas exhibited the hematocrit effect, which were all located in soft tissues and parenchymal organs.

RSH is a rare clinical entity characterized by accumulation of blood within the rectus abdominis muscle sheath and is caused by rupturing of the superior or inferior epigastric vessels or their branches or by tearing of the rectus abdominis muscle fibers. RSH must be suspected in elderly patients who are under coagulation medication and have acute abdominal pain. RSH can mimic other acute abdomen causes (19-21). The most frequent location is infraumblical, below the arcuate line where the posterior rectus sheath is deficient and the epigastric vessels are relatively fixed as well as more prone to sharing. Most cases are self-limiting and unilateral. Further, the most common triggering factor is acute paroxysmal coughing and other factors are the causes of increased intra-abdominal pressure (i.e., vomiting or straining during urination and defecation) (22). Based on the CT classification by Berna´et al., RSHs are classified as type I (mild), type II (moderate), and type III (severe) (23). Our data is in congruence with other studies in which RSHs were more commonly infraumbilically and unilaterally and more frequent in female patients (Figure 1). RSH should be suspected in patients who present with abdominal pain and abdominal mass, particularly if they are elderly, female, undergoing anticoagulant therapy, or have a cough.

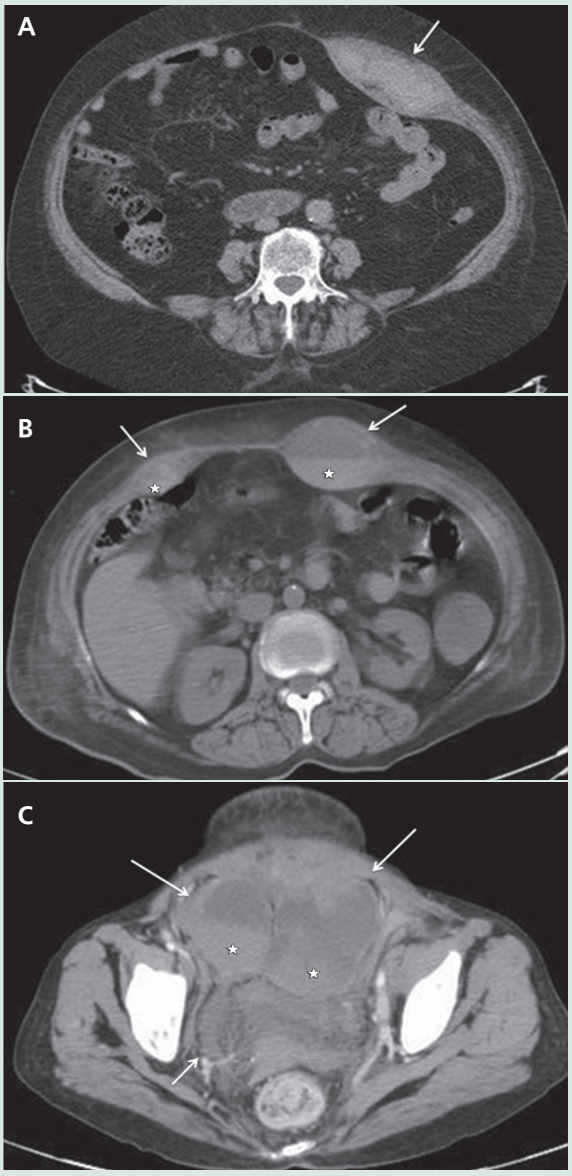

Figure 1. Rectus sheath hematomas: type I (mild), type II (moderate), and type III (severe).

A. Left-sided, type I, rectus sheath hematoma (arrow) in a 73-year-old female on LMWH (60 mg/day) for prophylaxis of pulmonary thromboembolism. An axial contrast-enhanced CT image shows an intramuscular hematoma that increased the muscle size.

B. Bilateral, type II, rectus sheath hematoma (arrows) in a 72-year-old female on warfarin (5 mg/day) and LMWH (40 mg/day) for mitral valve replacement. An axial contrast-enhanced CT image shows an intramuscular hematoma that increased the size of the muscle, had an hematocrit effect (star), and caused fascial plane thickening.

C. Bilateral, type III, rectus sheath hematoma (long arrows) in a 47-year-old female on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement. An axial contrast-enhanced CT image shows an intramuscular hematoma that increased the size of the muscle, had a hematocrit effect (star) and caused fascial plane thickening and prevesical space extension (short arrow).

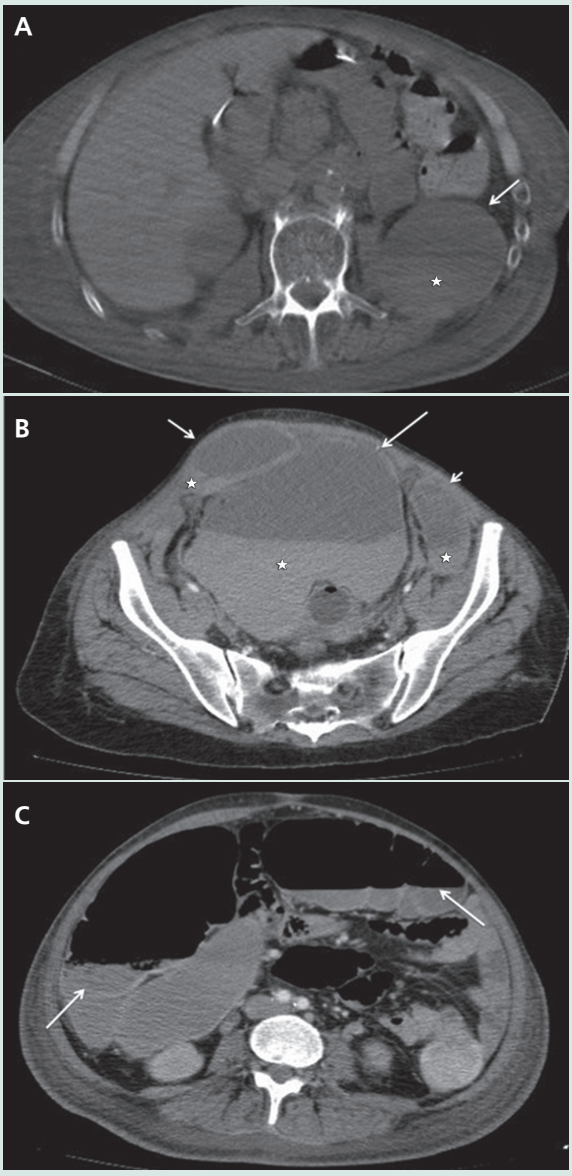

Figure 2. Retroperitoneal hematoma and abdominal compartment syndrome.

A. Left-sided retroperitoneal hematoma (arrow) in an 83-year-old male on LMWH (60 mg/day) for cerebrovascular disease. An axial unenhanced CT image shows intramuscular hematoma that increased the muscle size. Note the hematocrit effect (star).

B. A 54-year-old female on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement presented with right-sided rectus sheath (short arrow), intraperitoneal (long arrow), and left-sided retroperitonal (arrowhead) hematomas. The initial contrast-enhanced CT demonstrates multiple hematomas with a hematocrit effect (stars), extending into the pelvis and displacing the bladder inferiorly.

C. Ten days later, abdominal compartment syndrome developed because of multiple hematomas. A repeat contrast-enhanced CT reveals intestinal dilatation with fluid levels (arrows) secondary to increased intra-abdominal pressure.

Retroperitoneal hematomas are spontaneously observed in most patients with bleeding abnormalities, undergoing anticoagulant therapy, and undergoing hemodialysis. Several hypotheses about the mechanism of these hematomas include muscular strain, diffuse small vessel atherosclerosis, heparin-induced microangiopathy, and unrecognized minor trauma. Clinical symptoms vary from femoral neuropathy to ACS or fatal hypovolemic shock. ACS is the most serious condition associated with anuria; intestinal ischemia; and renal, cardiac, and respiratory failure (24,25). Similarly, in this study, one patient with retroperitoneal hematoma presented with bowel dilatation and increased intra-abdominal pressure-triggering ACS (Figure 2). In addition, anticoagulant-related hemorrhage may occur in the intraperitoneal space, i.e., spontaneous hemoperitoneum. Intraperitoneal hematomas are uncommon, but a serious condition, that may be catastrophic if not promptly diagnosed and treated (26).

Iliopsoas hematoma (IPH) can occur spontaneously with coagulopathy because of diseases, such as hemophilia, bleeding diathesis, or cirrhosis, and anticoagulation therapy. IPH originates from tearing of the muscle fiber. Further, patients with IPH present with femoral palsy as well as lumbar or groin pain (27). Under sedation, no symptoms occur, and the patient may present with potentially life-threatening hemorrhagic shock (28). In this study, IPHs were increasingly left-sided and unilateral (Figure 3A and Figure 3B).

Renal hematomas may be suburothelial, intraparenchymal, subcapsular, perinephric, and pararenal or may involve the renal sinus. Suburothelial and renal sinus hemorrhages are most commonly observed in patients undergoing anticoagulant therapy. Although rare, they may mimic neoplasms of the renal collecting system (29). Upon CT, suburothelial hemorrhages manifest as mural thickening of the renal pelvis, may involve the ureter, and compromise the lumen of the renal pelvis or ureter, resulting in ureterohydronephrosis (Figure 4). Several studies report that their complete resolution occurs as early as 2-4 weeks after conservative treatment (17,29,30).

GITHs can occur spontaneously within any segment of the gastrointestinal tract, i.e., from the esophagus to rectum. The most common cause of spontaneous intestinal hematoma is the anticoagulant use. Other known causes are hematologic disorders, lymphoproliferative diseases, collagenosis, vasculopathies, peptic ulcers, and pancreatitis (31). Spontaneous hematomas are rare and they tend to involve the jejunum as well as longer multiple segments. These affect elderly patients with risk factors for bleeding due to coagulopathy. Traumatic hematomas tend to involve the duodenum and short focal segments and are more frequent in younger patients. As reported, the most commonly involved segments are the jejunum (69%), followed by the ileum (%38) and duodenum; the colon and rectum are rarely involved. Spontaneous hematomas may occur in the esophagus and gastric wall. These may be submucosal, intramural, intraluminal, intramesenteric, and retroperitoneal, particularly, when the duodenum is involved (18,31). Comparatively, in this study, the ileum (36% of GITHs) was the most frequent location, followed by the jejunum (28%), duodenum, stomach, colon, and rectum (Figure 5-7). Further, all hematomas in this study were located intramurally.

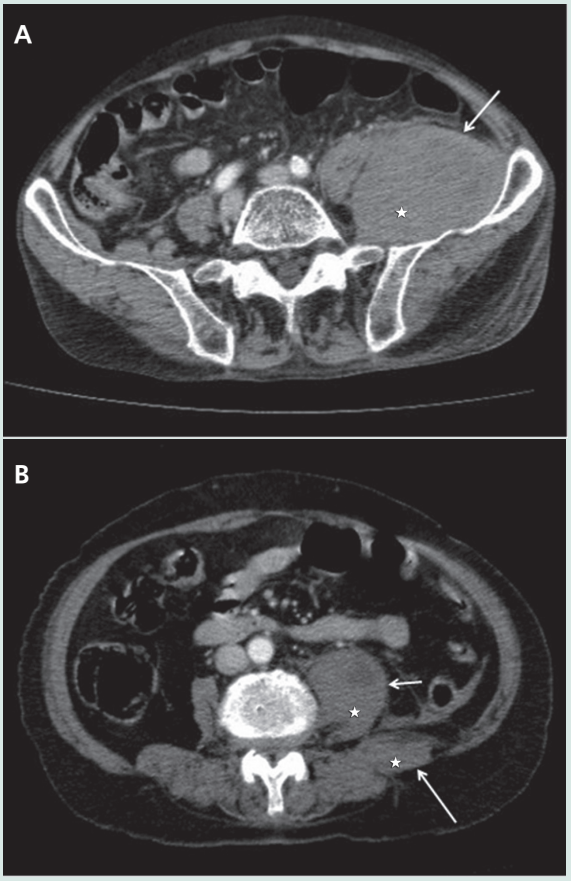

Figure 3. Iliopsoas and quadratus lumborum hematomas.

A. Left-sided iliopsoas hematoma (arrow) in a 78-year-old male on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement. An axial contrast-enhanced CT image shows intramuscular hematoma that increased the muscle size. Note the hematocrit effect (star).

B. Left-sided psoas hematoma (short arrow) and quadratus lumborum hematoma (long arrow) in an 81-year-old female on warfarin (5 mg/day) for atrial fibrillation and coronary artery disease. An axial contrast-enhanced CT image shows intramuscular hematomas that increased the size of both muscles. Note the hematocrit effect (stars).

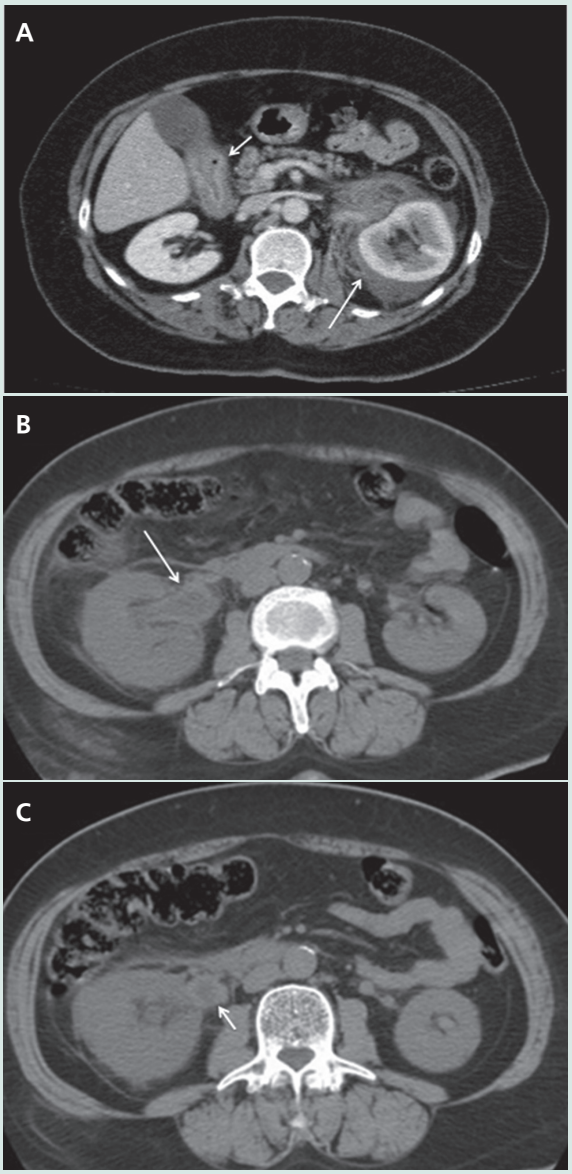

Figure 4. Renal hematomas.

A. A 66-year-old female on warfarin (5 mg/day) for peripheric artery disease presented with a left-sided perinephric renal hematoma (long arrow) and an intramural duodenal hematoma (short arrow). An axial contrast-enhanced CT image reveals a crescentic hemorrhage into the left perirenal area and concentric bowel thickening of the second part of the duodenum.

B and C. A 57-year-old female on warfarin (5 mg/day) for mitral valve replacement presented with suburothelial hematomas at the right kidney and ureter. An axial contrast-enhanced CT image demonstrates hyperdense thickening of the renal pelvis (long arrow) and proximal ureter (short arrow).

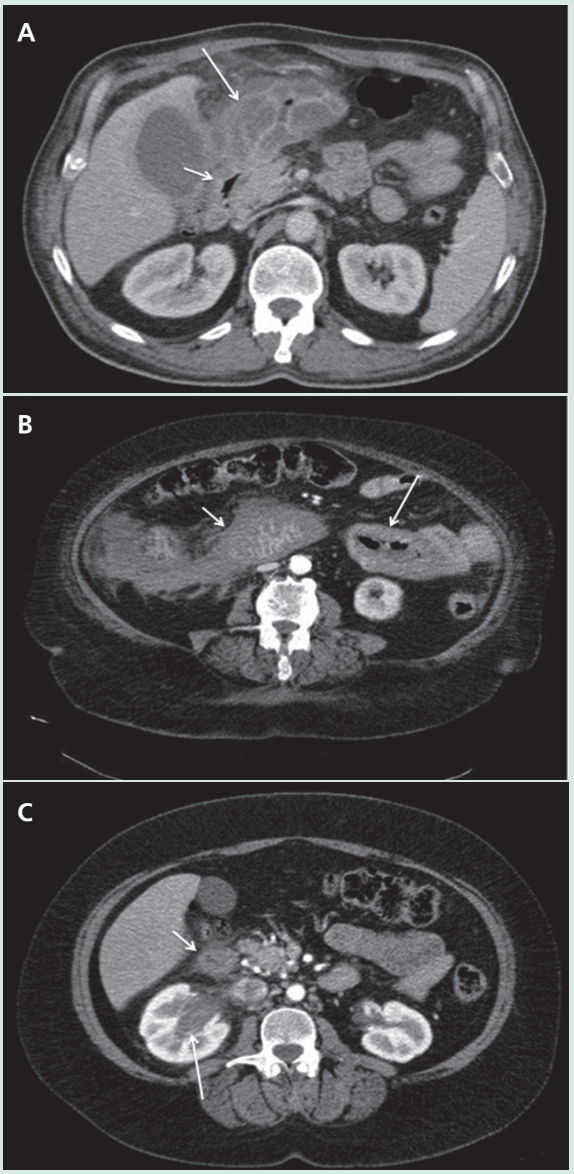

Figure 5. Intramural hematomas of the gastrointestinal tract: gastric and duodenal.

A. A 61-year-old male on warfarin (5 mg/day) for atrial fibrillation and cerebrovascular disease presented with intramural gastric and duodenal hematomas. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening of the antrum (long arrow) and first part of the duodenum (short arrow).

B. A 74-year-old female on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement presented with intramural duodenal and jejunal hematomas. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening of the third part of the duodenum (short arrow) and proximal jejunum (long arrow).

C. A 74-year-old female on warfarin (5 mg/day) for treatment of pulmonary embolism presented with suburothelial renal hematomas, duodenal, and jejunal hematomas. An axial contrast-enhanced CT image demonstrates hyperdense thickening of the renal pelvis (long arrow) and circumferential bowel thickening of the second part of the duodenum (short arrow) and distal jejunum (not shown).

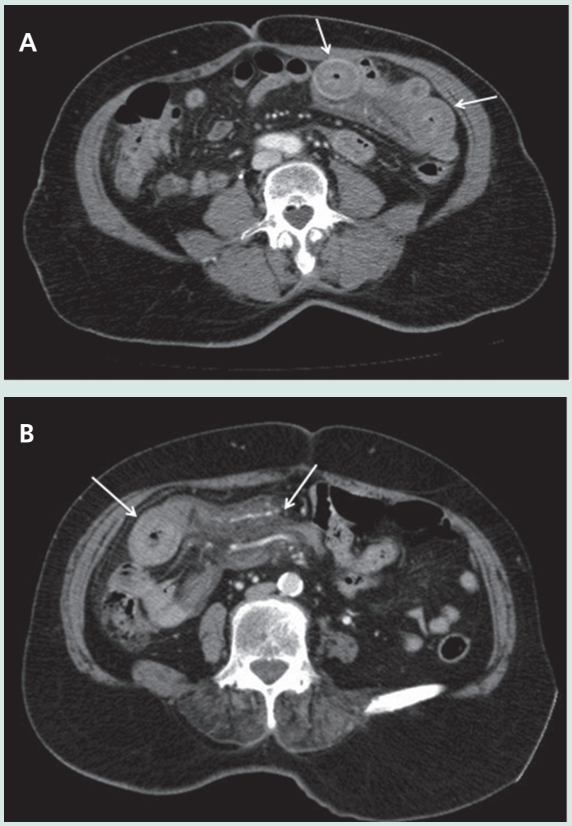

Figure 6. Intramural hematomas of the gastrointestinal tract: jejunum and ileum.

A. Jejunal hematoma in an 84-year-old female on warfarin (5 mg/day) for atrial fibrillation and congestive heart failure. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening of the jejunal segments (short arrows) and peri-intestinal hemorrhage.

B. Ileal hematoma in a 71-year-old female on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening of the ileal segments (long arrows) and peri-intestinal hemorrhage.

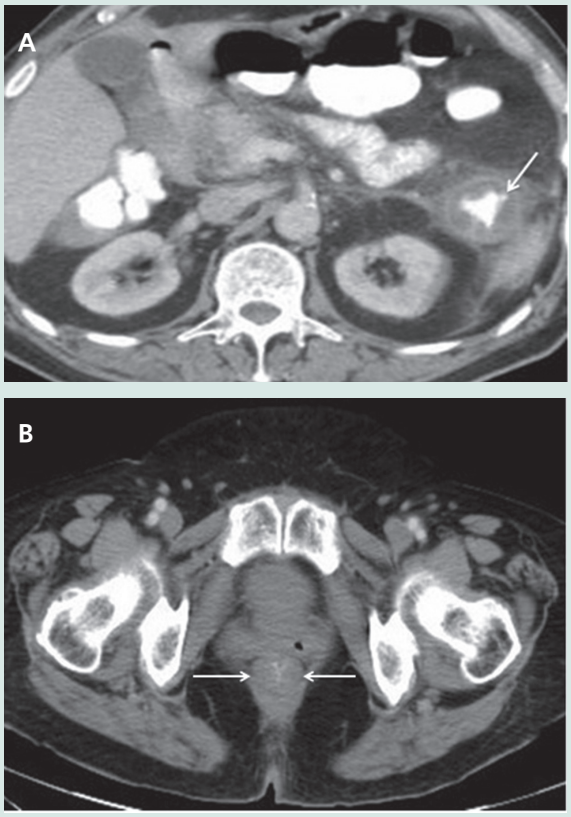

Figure 7. Intramural hematomas of the gastrointestinal tract: colon and rectum.

A. Colonic hematoma in a 75-year-old male on warfarin (5 mg/day) for atrial fibrillation and mitral valve replacement. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening and fluid collection surrounding the descending colon (arrow).

B. Rectal hematoma in a 57-year-old male on warfarin (5 mg/day) for atrial fibrillation and chronic obstructive pulmonary disease. An axial contrast-enhanced CT image demonstrates circumferential bowel thickening of the rectum (long arrows).

Spontaneous adrenal hematomas are rare, and the most common causes are coagulopathy, neonatal stress, underlying tumors, and idiopathic disease. Adrenal hematomas due to coagulopathy tend to be bilateral. Clinical manifestations are varied and dependent on the amount of hemorrhage and signs of adrenal insufficiency (32). Hematomas characteristically appear as an adrenal enlargement with surrounding periadrenal hemorrhage. Similarly, in our study, the hematoma was bilateral and the patient presented with only non-specific abdominal pain without adrenal insufficiency (Figure 8).

Ovarian hematomas are extremely rare, but should be considered in the differential diagnosis of acute abdominal pain in women with congenital and acquired coagulation deficiencies. Hematomas may appear as hemorrhages in ovarian cysts and highly attenuated ovarian enlargement with surrounding hemorrhage (Figure 9). It must be kept in mind that ovarian hemorrhages can mimic and co-exist with other acute abdominal emergencies, such as appendicitis (26).When performing CT, ovarian hematomas should be included in the differential diagnosis of highly attenuated adnexal masses (33).

Pectineus and quadratus muscle hematomas are described in the literature as rare cases and are likely to be under-diagnosed because of their ability to imitate other more known acute abdominal emergencies (34). Our

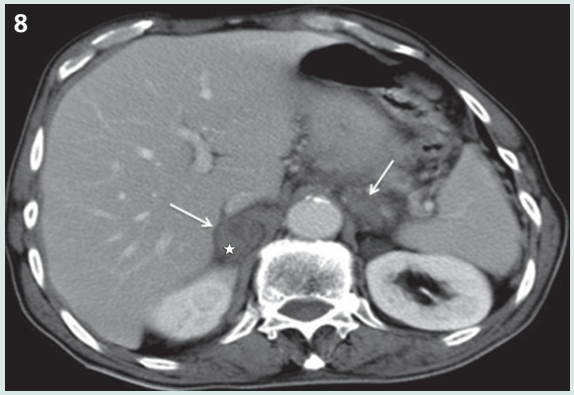

Figure 8.

Bilateral adrenal hematomas in a 70-year-old male on LMWH (40 mg/day) for prophylaxis of pulmonary embolism after a hip operation. An axial contrast-enhanced CT image shows hematomas that increased the size of the adrenal glands bilaterally (arrows) and with a hematocrit effect (star) in the right adrenal gland.

Figure 9.

Left-sided ovarian hematoma in a 29-year-old female on warfarin (5 mg/day) for mitral valve replacement. An axial contrast-enhanced CT image shows inhomogeneous hematoma that increased the size of the left ovary (arrow).

Figure 10.

Left-sided pectineus, rectus sheath (not shown), retroperitonal, and ileal hematomas (not shown) in a 55-year-old female on warfarin (5 mg/day) and clopidogrel (75 mg/day) for mitral valve replacement. An axial contrast-enhanced CT image shows intramuscular hematomas with increased pectineus muscle size (long arrow) and retroperitoneal hemorrhage (short arrow).

study included a left-sided pectineus hematoma in one patient who was on warfarin, clopidogrel, and ASA (Figure 10). Our patient with quadratus lumborum hematoma, to the best of our knowledge, is the first reported case in English literature (Figure 3B).

In all types of anticoagulant-related abdominal hematomas, the treatment depends on the clinical situation, coagulation status, and hemodynamic instability. Minor hemorrhages can be treated conservatively. Surgical intervention and endovascular embolization may be necessary for major hemorrhages, particularly, those with hemodynamic instability (25,28). As such, the mortality rate in our study was 12.7%, whereas that in recent studies ranged between 1% and 14% (4).

We acknowledge potential data limitations of a retrospective study design. Further, we did not have access to information regarding the concurrent medication use and anticoagulant treatment duration. Other study limitations include the relatively small number of patients, lack of a control group, and the short follow-up.

Anticoagulant-related abdominal hematomas are uncommon but may be life-threatening. The diagnosis is based on a patient's clinical history, physical examination, and imaging findings. Clinicians and surgeons should be aware of this rare complication, which is frequently observed in elderly patients undergoing anticoagulant therapy and presenting with abdominal pain. Radiologists play a pivotal role in the timely diagnosis of anticoagulant-related abdominal hematomas to avoid unnecessary surgeries; most hematomas will spontaneously resolve through conservative treatment options. Understanding the most common clinical and CT findings allows for accurate diagnosis and therapeutic management of anticoagulation-related abdominal hematomas.

Compliance with ethical standards

Conflict of interest: *The authors declare that they have no conflict of interest.*

Ethical statement: *This retrospective study was approved by our Institutional Review Board, and informed consent was waived.*

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