ACE inhibitor-induced angioedema of the intestine:
Case report, incidence, pathophysiology, diagnosis and management

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G Oudit, N Girgrah, J Allard. ACE inhibitor-induced angioedema of the intestine: Case report, incidence, pathophysiology, diagnosis and management. Can J Gastroenterol 2001;15(12):827-832. A case report of fosinopril-induced angioedema of the intestine with a chronic course accompanied by multiple acute exacerbations is described. Angiotensin-converting enzyme (ACE) inhibitor-induced angioedema of the intestine (AIAI) occurs in a minority of patients taking an ACE inhibitor. The clinical presentation encompasses acute abdominal symptoms, pronounced bowel edema and ascites with occasional facial and/or oropharyngeal swelling. AIAI is diagnosed based on the temporal relationship between the symptomatic presentation and drug use, absence of alternative diagnoses including other causes of angioedema, and the prompt resolution of symptoms upon discontinuation of the ACE inhibitor. Prompt radiological investigation (abdominal computerized tomography and/or ultrasound) is critical in making an early diagnosis and in preventing unnecessary surgical intervention. There is a female predominance of AIAI, which may reflect the interaction of estradiol with the various pathways involved in the pathophysiology of AIAI. Management of AIAI consists mainly of conservative measures and discontinuation of the ACE inhibitor. Angiotensin II receptor antagonists should not be considered as appropriate alternatives. Awareness and knowledge of AIAI are important because of the increasing use of ACE inhibitors, current delays in making the diagnosis, obvious management strategies once the diagnosis is made and the dysutility of alternative diagnoses, which may lead to considerable morbidity. AIAI must be considered in patients taking ACE inhibitors who develop gastrointestinal complaints irrespective of the duration of the therapy.

Key Words: Abdominal pain; Angioedema; Angiotensin-converting enzyme (ACE) inhibitor; Sex

Oedème angioneurotique de l'intestin et inhibiteurs de l'ECA : exposé de cas, incidence, physiopathologie, diagnostic et traitement

RÉSUMÉ : Voici un exposé de cas d’œdème angioneurotique chronique de l’intestin provoqué par le fosinopril et émaillé de nombreux épisodes d’exacerbation. Les inhibiteurs de l’enzyme de conversion de l’angiotensine (ECA) entraînent, chez une minorité de patients, un œdème angioneurotique de l’intestin (OAI). Le tableau clinique comprend des symptômes abdominaux aigus, un œdème marqué de l’intestin, de l’ascite et parfois une tuméfaction de la face ou de l’oropharynx. Le diagnostic...
The proven benefits of angiotensin-converting enzyme (ACE) inhibitors in the management of congestive heart failure, hypertension, and diabetes mellitus-related cardiovascular and renal complications have led to a tremendous increase in their use in the past decade. As such, adverse effects of ACE inhibitors are increasingly being recognized and reported (1-6). Cough, the most common side effect of ACE inhibitor therapy, occurs in 5% to 20% of patients and is more common in women than in men (1). Angioedema, a potentially life-threatening complication, occurs in 0.1% to 0.2% of patients receiving ACE inhibitors, with 60% of cases presenting within the first week (1-6). The incidence of angioedema is fivefold higher in black people, but is independent of age and dose of ACE inhibitor (3,5). The typical presentation of angioedema involves swelling of the facial and/or oropharyngeal tissue with occasional dermatological manifestations.

Delay in diagnosis and the continuing use of ACE inhibitors are associated with recurrent angioedema and serious morbidity (4-8). The percentage of patients with reported cases of delayed onset of angioedema, defined as the first appearance of symptoms after six months and up to six years, is continually increasing over time. For example, in 1992, 1996 and 1998, 8.9%, 28% and 54% of patients, respectively, presented with delayed angioedema as the first mode of clinical presentation (8). The two major gastrointestinal manifestations of ACE inhibitor adverse effects are angioedema of the intestine (4,9-19) and acute pancreatitis (20,21). The connection between the more common forms of angioedema and gastrointestinal involvement was recognized by Osler (22), who stated that “associated with the oedema there is almost invariably gastrointestinal disturbance: colic, nausea, vomiting, and sometimes diarrhea”.

Although there have been several recent case reports of ACE inhibitor-induced angioedema of the intestine (AIAI), the primary gastroenterology literature has failed to incorporate this important adverse drug reaction of ACE inhibitor as a cause of a distinct gastroenterological disorder. As such, the purpose of this review article is to illustrate a case of AIAI, identify and summarize all case reports of AIAI, and provide an approach to AIAI with an emphasis on incidence, pathophysiology, diagnosis and management. A computerized search of MEDLINE for English-language articles using the PubMed search engine was conducted using the following MeSH (medical subject heading) terms: ‘angioedema’, ‘ACE inhibitors’, ‘intestine’ and ‘abdominal pain’ in various combinations. Relevant articles were also identified through a manual review of references.

CASE PRESENTATION

A 37-year old woman with a prior history of gastrointestinal disorders presented to the emergency department with acute onset of painful abdominal cramps, nausea, and several episodes of vomiting and watery diarrhea. Her past medical history was remarkable for essential hypertension and chronic gastrointestinal complaints, with several visits to the emergency department. Two days before presentation, the dose of fosinopril (ACE inhibitor) was increased from 10 mg once daily to 30 mg once daily. She was also taking an oral contraceptive. She had no known allergies to drugs or environmental agents, and her travel history was negative. There was no family history for any diseases. The patient was afebrile, and no facial or oropharyngeal swelling was noted. Mild diffuse abdominal tenderness with bulging flanks and flank dullness were present.

Investigations revealed a normal complete blood cell count, serum electrolytes, serum amylase, liver enzymes, liver function test results, coagulation and renal function test results. Viral serology (hepatitis B, C, cytomegalovirus and Epstein-Barr) was negative, and no toxins or infectious organisms were isolated from stool specimens. Ascitic fluid had a clear yellow appearance with an exudative pattern; microbiology cultures, including acid-fast bacilli, were unrevealing. Autoimmune serology including erythrocyte sedimentation rate, rheumatoid factor, antinuclear antibodies and antineutrophil cytoplasmic antibodies were negative. Complement (C3 and C4) and C1 esterase inhibitor (C1-INH) levels were normal. Urinalysis results were normal with a negative urobiligenogen screen. Upper endoscopy and colonoscopy results were normal. Ileal and colono-scope biopsy specimens had normal histological appearance, and cultures were negative for any bacteria, viruses and acid-fast bacilli. A computerized tomography (CT) scan (with intravenous and oral contrast) and ultrasound of the abdomen (with Doppler interrogation) were done (Figure 1). Blood flow in the portal, superior mesenteric and hepatic veins, and the hepatic/biliary system was normal. The pancreas appeared normal and there was no evidence of lymphadenopathy. AIAI was diagnosed based on the criteria listed in Table 1; fosinopril was discontinued, and her symptoms abated in 24 h. Follow-up over a one-year period revealed no recurrence of symptoms.
INCIDENCE OF AIAI

Despite the well-documented incidence of cutaneous and/or facial/oropharyngeal angioedema (see above), no study has systematically examined the incidence of AIAI in patients taking ACE inhibitors. Several lines of evidence suggest that angioedema of the intestine is underdiagnosed, and more recent data have highlighted the clinical importance of AIAI. First, acute nonspecific abdominal pain (NSAP) accounts for 13% to 40% of all emergency surgical admissions and is associated with an extensive series of investigations (23). Despite further investigations at substantial cost, about one-third of all patients with acute abdominal pain leave the hospital without a final diagnosis. Although drug-induced angioedema may be partly responsible for acute NSAP, most studies fail to report a detailed drug history (23).

Second, angioedema occurred in 0.4% of the 4645 patients who received ramipril in the Heart Outcomes Prevention Evaluation (HOPE) study (compared with 0.2% in the placebo group) (24). Given the high level of ACE inhibitor usage worldwide, with approximately 35 to 40 million patients exposed to ACE inhibitors, the morbidity and/or mortality from AIAI could be considerable (25).

Third, the recent use of a combined ACE and neutral endopeptidase (NEP) inhibitor, omapatrilat, in patients with heart failure has led to an increased incidence of angioedema with a concomitant 35% incidence of gastrointestinal adverse effects, including diarrhea and abdominal pain (26). Increased angioedema is not unexpected because both enzyme systems inactivate bradykinin, an important mediator of angioedema (Figure 2). Given this important adverse reaction, there has been a temporary withdrawal of the new drug application for omapatrilat (25).

PATHOPHYSIOLOGY

The precipitation of angioedema involves an interaction of environmental triggers in genetically susceptible individuals. The pathophysiological mechanisms involve an interaction between immunological factors, complement pathways and various peptidergic and aminergic byproducts.
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is contraindicated in women with hereditary angioedema (33). Indeed, estrogen use via contraceptive or HRT with an increased risk of ACE inhibitor-induced angioedema (33). Lower levels of C1-INH are associated with a proportionately greater increase in bradykinin levels (Figure 2). As such, the addition of an ACE inhibitor may cause a proportionately greater reduction in ACE activity (31) (Figure 2). As such, the addition of an ACE inhibitor may cause a proportionately greater increase in bradykinin levels (HA) (29). As such, women during the pre- and perimenopausal periods, as well as those taking estrogen-containing preparations, may be more prone to ACE inhibitor-induced angioedema because the reduced inhibitor function of C1-INH (complement pathway) may predispose the tissues to the increased bradykinin levels (ACE pathway) following ACE inhibition.

### DIAGNOSTIC APPROACH

A total of 13 case reports describing AIAI have revealed several characteristic features of the disease (Table 1). Patients often have recurrent episodes of abdominal complaints and are sometimes given an alternative diagnosis with occasional surgical intervention (4,9-19). The time of diagnosis varied from a few hours to seven years following the initiation of ACE inhibitor, with over 75% of patients (10 of 13 patients) having a delayed diagnosis (two months or longer), and was independent of the dose of ACE inhibitor (9-19). This was likely due to a delay in presentation and/or diagnosis. Patients reported a chronic use of ACE inhibitors associated with recurrent gastrointestinal symptoms and multiple episodes of acute exacerbations. Gastrointestinal symptoms in patients taking ACE that cannot be explained by other more common causes should prompt physicians to consider AIAI, irrespective of the duration of therapy. In addition, several patients had prior episodes of angioedema involving the face and/or oropharynx. As such, a diagnosis of ACE inhibitor-induced angioedema of the face and/or oropharynx does not preclude the possibility of AIAI.

Radiological studies (contrast-enhanced CT and/or ultrasonography) are instrumental in documenting the location and extent of bowel edema and ascites and their resolution. The characteristic radiological findings of AIAI are similar to those of HA (34-41) and include segmental thickened bowel wall (small and/or large intestine), nar-

### TABLE 2

Summary of all case reports describing angiotensin-converting enzyme (ACE) inhibitor-induced angioedema of the intestine

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (years)</th>
<th>Sex</th>
<th>ACE inhibitor (dose, mg)</th>
<th>Treatment duration</th>
<th>Presentation</th>
<th>Author (reference), year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>41</td>
<td>F</td>
<td>Enalapril (5)</td>
<td>12 h</td>
<td>AAS, bowel edema</td>
<td>Farraye et al (19), 1988</td>
</tr>
<tr>
<td>2</td>
<td>48</td>
<td>F</td>
<td>Captopril (37.5)</td>
<td>3 years</td>
<td>AAS, FOS, ascites</td>
<td>Matsumura et al (18), 1993</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
<td>F</td>
<td>Enalapril (5)</td>
<td>9 weeks</td>
<td>AAS, FOS</td>
<td>Jacobs et al (17), 1994</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>F</td>
<td>Lisinopril (20)</td>
<td>10 months</td>
<td>AAS, ascites</td>
<td>Guy et al (16), 1994</td>
</tr>
<tr>
<td>5</td>
<td>59</td>
<td>F</td>
<td>Enalapril (NR)</td>
<td>7 years</td>
<td>AAS, bowel edema</td>
<td>Mullins et al (15), 1996</td>
</tr>
<tr>
<td>6</td>
<td>58</td>
<td>F</td>
<td>Lisinopril (NR)</td>
<td>Several days</td>
<td>AAS, FOS, bowel edema</td>
<td>Gregory and Davis (14), 1996</td>
</tr>
<tr>
<td>7</td>
<td>41</td>
<td>F</td>
<td>Lisinopril (5)</td>
<td>2 days</td>
<td>AAS, ascites, bowel edema</td>
<td>Abdelmalek and Douglas (13), 1997</td>
</tr>
<tr>
<td>8</td>
<td>61</td>
<td>M</td>
<td>Captopril (200)</td>
<td>5 years</td>
<td>AAS, FOS</td>
<td>Smoger and Sayed (12), 1998</td>
</tr>
<tr>
<td>9</td>
<td>46</td>
<td>F</td>
<td>Enalapril (2.5)</td>
<td>5 years</td>
<td>AAS, FOS, bowel edema</td>
<td>Jardine et al (11), 1999</td>
</tr>
<tr>
<td>10</td>
<td>72</td>
<td>F</td>
<td>Lisinopril (5-20)</td>
<td>5 months</td>
<td>AAS, bowl edema</td>
<td>Chase et al (10), 2000</td>
</tr>
<tr>
<td>11</td>
<td>67</td>
<td>F</td>
<td>Fosinopril (NR)</td>
<td>3 years</td>
<td>AAS, FOS, ascites, bowel edema</td>
<td>Byrne et al (4), 2000</td>
</tr>
<tr>
<td>12</td>
<td>41</td>
<td>F</td>
<td>Lisinopril (20)</td>
<td>2 years</td>
<td>AAS, ascites, bowel edema</td>
<td>Byrne et al (4), 2000</td>
</tr>
<tr>
<td>13</td>
<td>37</td>
<td>F</td>
<td>Lisinopril (30)</td>
<td>6 years</td>
<td>AAS, ascites, bowel edema</td>
<td>Oudit et al (9), 2000</td>
</tr>
</tbody>
</table>

AAS Acute abdominal symptoms (nausea, vomiting, abdominal pain/distension, diarrhea); F Female; FOS Facial and/or oropharyngeal swelling; M Male; NR Not reported
rowed lumen, and prominent and thickened valvulae con
niventes, often with the presence of ascites (4,9-19)
(Figure 1). An extensive history and series of investigations
are essential to rule out allergic, C1-INH deficiency (hered-
itary and acquired), inflammatory (including infectious),
vascular (including lymphatic blockage and hemorrhage),
and other miscellaneous causes of ascites and bowel edema.
Documented causes of angioedema of the intestine include
the use of ACE inhibitors (AIAI) (4,9-19), dual inhibitors
of ACE and neutral endopeptidase (eg, omapatrilat)
(30,42), allergic reactions to drugs, food and radiographic
contrast agents (30,42), HA with and without the use of
ACE inhibitor (34-40) and malignancy-associated paraneo-
plastic manifestation (40,41).

Routine evaluations should include hematological, bio-
chemical, microbiological and radiological investigations as
well as ascitic fluid analysis. Inadequate inhibition of the
first component of human complement (C1-INH) gives rise
to HA and an acquired form of angioedema (43). HA is
commonly diagnosed when patients present with recurrent
gastrointestinal symptoms and bowel edema (34-40). As
such, complement (C3, C4 and CH50), C1q and C1-INH
levels should always be measured with samples taken during
the symptomatic period to increase the diagnostic yield
(41). Moreover, the diagnosis of HA, irrespective of the use
of ACE inhibitor, has important and unique management
strategies (34-41,43). When radiological studies reveal
large bowel involvement, a colonoscopy with mucosal
biopsy is beneficial in excluding diagnoses of an inflamma-
tory and/or vascular origin.

AIAI was diagnosed based on the temporal relationship
between the use of an ACE inhibitor, absence of alternative
diagnoses and the resolution of symptoms upon discontinu-
ation of the ACE inhibitor (Table 2). A follow-up assess-
ment(s) with a repeat radiological procedure (abdominal
CT or ultrasound) is of critical importance in the postdis-
charge period to confirm a complete resolution of the
ascites and bowel wall edema and to substantiate the diag-
nosis. A rechallenge with an ACE inhibitor should not be
attempted.

MANAGEMENT OF AIAI

Although approximately half of the patients with AIAI had
prior presentations involving facial and/or oropharyngeal
swelling, no patient had concomitant airway compromise
(4,9-19). However, a cautionary approach must be taken,
and respiratory status must be closely monitored in these
patients. Patients should continue to receive nothing by
mouth, and be given supportive care and adequate fluid
resuscitation, and the ACE inhibitor should be continu-
ued. The possible development of hypovolemia and small
bowel obstruction must be closely monitored in the acute
setting. However, in all nine cases described, symptoms
resolved within 24 to 48 h without the need for specific
medical therapy. In particular, there is no role for antihista-
mine or corticosteroids during the acute symptomatic
period. The reversible nature of the disorder is clearly
revealed by the prompt resolution of symptoms once the
diagnosis is made and the offending drug discontinued.

Follow-up care is crucial to establish a continued resolu-
tion of symptoms and to confirm the diagnosis. The long
term management issues involve a life-long abstinence from
ACE inhibitors and the use of an alternative agent(s).
Angiotensin II receptor antagonists (ARA) are not suitable
substitutes for ACE inhibitors in patients diagnosed with
AIAI. Angioedema has also been reported with ARA,
albeit with a lower incidence and/or severity, irrespective of
a prior history of ACE inhibitor-induced angioedema (6).
For example, 32% of patients with reported ARA-induced
angioedema had experienced a prior episode of angioedema
attributed to ACE inhibitor therapy (6). ARA, via an indi-
rect pathway, may lead to inhibition of endogenous ACE
activity (Figure 2). Unless the patient has documented C1-
INH deficiency, the use of synthetic androgens (danazol or
stanozolol) is not indicated. We recommend that a safety
wrist bracelet be worn so that health professionals can be
forewarned of the underlying medical condition.

CONCLUSIONS

Given the high prevalence of nonspecific abdominal pain
in our population, drug-related causes for abdominal com-
plaints must be carefully sought. Angioedema involving the
gastrointestinal system should be considered in patients
taking ACE inhibitors who present with acute and/or
chronic abdominal symptoms, irrespective of the duration
of therapy. AIAI is an important diagnosis because the
dysutilty of a delayed and/or missed diagnosis is consid-
erable, and treatment options are simplistic and straightfor-
ward. Prompt radiological investigation(s) during the
symptomatic phase is a key component to making the diag-
nosis. AIAI is completely reversible following the discon-
 tinuation of the offending ACE inhibitor. HA must be
ruled out as an important comorbidity. ARAs should not be
used as substitutes for the ACE inhibitors.

REFERENCES

1. Israili ZH, Hall WD. Cough and angioneurotic edema associated with
angiotensin-converting enzyme inhibitor therapy. A review of the
2. Galb GH, Wing LMH, Ryan P, Hutchinson KA. Epidemiological
study of angioedema and ACE inhibitors. Aust NZ J Med
1996;26:777-82.
3. Brown NJ, Ray WA, Snowden M, Griffin MR. Black Americans have
an increased rate of angiotensin converting enzyme inhibitor
angioedema: and underdiagnosed complication of ACE inhibitors?
5. Veening W, van Amsterdam JGC, Sticker BHC, de Wildt Dj. ACE
inhibitor-induced angioedema. Incidence, prevention and
6. Warner KK, Visconti JA, Tischamp MM. Angiotensin II receptor
blockers in patients with ACE inhibitor-induced angioedema. Ann
7. Brown NJ, Snowden M, Griffin MR. Recurrent angiotensin-
converting enzyme inhibitor-associated angioedema. JAMA
1997;278:232-3.
8. Wernze H. ACE inhibitor-induced angioedema: remarkable
new perspectives for intensive care/emergency medicine.
26. Rouleau JL, Pfeffer MA, Stewart DJ, et al. Comparison of 
vasopressin-induced angioedema of the intestine. Gastroenterology 

25. Messerli FH, Nussberger J. Vasopeptidase inhibition and angio-


23. Poulin EC, Schlachta CM, Mamazza J. Early laparoscopy 
to help diagnose acute non-specific abdominal pain. Lancet 
1995;346:89-90.


20. Maringhini A, Termini A, Patti R, Ciambra M, Biffarella P, 
Pagliaro L. Enalapril-associated acute pancreatitis: recurrence after 


to be associated with angiotensin-converting enzyme inhibitor. Intern Med 

17. Jacobs RL, Hoberman LJ, Goldstein HM. Angioedema of the small 
bowel due to an angiotensin-converting enzyme inhibitor. Ann J 
Gastroenterol 1999;94:290-1.


15. Mullins RJ, Shanahan TM, Dobson RT. Visceral angioedema related 


12. Smoger SH, Sayed MA. Simultaneous mucosal and small-bowel 

11. Jardine DL, Anderson JC, McClintock AD. Delayed diagnosis of 
recurrent visceral angio-oedema secondary to ACE inhibitor therapy. 

10. Chase MP, Fiarman GS, Scholz FJ, MacDermott RP. Angioedema of 


8. Polger M, Kuhlman JE, Hansen FC, Fishman EK. Computed 
tomography of angioedema of small bowel due to reaction to 
computed tomographic contrast medium. J Comput Assist Tomogr 
1993;161:1215-6.

287 patients with hereditary angioedema. J Allergy Clin Immunol 

current abdominal pain and ascites. J Allergy Clin Immunol 

infrquent cause of abdominal pain with ascites. Am J Gastroenterol 

4. Weinstock LB, Kothari T, Sharma RN, Rosenfeld SL. 
Recurrent abdominal pain as the sole manifestation of hereditary 
angioedema in multiple family members. Gastroenterology 
1987;93:1116-8.

3. Watt R, Higgs ER. Acute and recurrent abdominal pain due to 

2. Eakin S, Morse JH, Janssen DA, Emerson SG, Markovitz DM. 
Angioedema presenting as chronic gastrointestinal symptoms. 

1. Ciaccia D, Brazer SR, Baker ME. Acquired C1 esterase inhibitor 
deficiency causing intestinal angioedema: CT appearance. 

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