Diverticular disease of the colon

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Diverticulosis of the colon is quite frequent in developed countries and prevalence rises with age. Although up to two-thirds of people older than age 80 years are affected, most remain asymptomatic. The causes of colonic diverticula include alterations in colonic wall resistance, disordered colonic motility, and dietary deficiencies, especially fibre. Clinical manifestations of this disorder range from non-specific intermittent abdominal pain to potentially life-threatening complications such as diverticulitis or haemorrhage. CT scanning and colonoscopy are important in diagnosis and management. Here, we review epidemiology, causes, clinical presentation, and management of diverticular disease of the colon.

Epidemiology

Prevalence of colonic diverticulosis is difficult to measure because most patients are asymptomatic. In early (1920–1940) autopsy and barium enema series, rates of 2–10% were reported. Data show a substantial rise in prevalence seen in the USA, Europe, and Australia. Within a given country, the incidence of colonic diverticula can vary in ethnic groups—eg, in Chinese inhabitants of Singapore, the sigmoid colon, and asymptomatic, but can present with infection, obstruction, or perforation.

Pathological anatomy

Diverticula vary from solitary findings to many hundreds. They are typically 5–10 mm in diameter but can exceed 2 cm. An entity of giant colonic diverticula has been described with sizes up to 25 cm. Most are single, located in the sigmoid colon, and asymptomatic, but can present with infection, obstruction, or perforation.

Search strategy and selection criteria

Sources of information included: authors’ published work and research; and original research, reviews, and practice guidelines identified by computer database search—eg, MEDLINE, LexisNexis, The Cochrane Library, and Science Citation Index. Most recent publications were prioritised. Search terms included: “diverticulosis”, “diverticulitis”, “diverticular disease”, “diverticular hemorrhage”, “gastrointestinal bleeding”, “diverticular abscess”, “diverticular fistula”, “colonoscopy”, “endoscopy”, “epidemiology”, “pathogenesis”, “motility”, “fiber”, “computerized tomography”, “CT-scanning”, “surgery”, “laparoscopic”, “ultrasound”, “ultrasonography”, “barium enema”, “contrast enema”, “NSAID”, and “non-steroidal anti-inflammatory”, with Boolean operators AND and OR. Human and animal studies in the English language were reviewed and manually crossreferenced.

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Although diverticulosis is an acquired disorder, findings of observational studies suggest that the disease pattern—eg, right-sided, pancolonic—might be established early on and then remain constant, rather than increasing over time in number and extent. In sequential studies with barium enema, no progression of disease has generally been noted in most patients. In fact, two distinct forms of diverticulosis might exist: one discernible by muscle thickening, mainly in the left colon, and associated with perforation and diverticulitis; the other due to a diffuse connective tissue abnormality, resulting in pancolonic diverticulosis and a propensity for bleeding. This possibility could, in part, account for anatomic differences described between European and US patients and those from Asia.

Cause and pathogenesis
Colonic wall resistance
Early gross descriptions of diverticular colons typically noted thickening of muscle wall and shortening of the taeniae coli, with resultant concertina-like bunching of hastral folds. Although muscle contraction is noted, routine histology has not generally indicated muscle hypertrophy. Findings of electron microscopic studies have shown that diverticular colonic walls consist of structurally normal muscle cells but elastin deposition is amplified by more than 200% in muscle cells in the taenia coli compared with those without diverticula. Elastin is laid down in a contracted form, resulting in shortening of the taenia coli and bunching of circular muscle. Age-related changes in collagen composition could have a causal role in weakening of wall resistance. An increase in type III collagen synthesis has been described. Further, changes in collagen crosslinking have been shown in animal and human models. The importance of gut wall connective tissue is underscored by early development of diverticula in patients with connective tissue disorders such as Marfan’s and Ehlers-Danlos syndromes.

Disordered motility
In the 1960s, Arfwidsson did manometry on patients with or without sigmoid diverticula and showed higher resting, postprandial, and neostigmine-stimulated luminal pressures in diverticular patients than in controls. Painter and colleagues confirmed these findings in response to neostigmine or morphine in individuals with sigmoid diverticula (intraluminal hypertension) and did simultaneous cineradiography. Painter suggested a theory of segmentation in which contraction of the colon causes a series of discrete “little bladders” (figure 1). He proposed that this segmentation had a physiological role in delaying of transport and augmentation of water reabsorption but could also generate excessively high pressures within every bladder, favouring herniation. This effect might be amplified by dietary fibre deficiency. Subsequently, patients with symptomatic diverticulosis have been shown to have higher motility indices than either asymptomatic patients or healthy controls. High right-sided pressures have also been recorded in patients with right-colon diverticulosis, suggesting that abnormal motility could also have a role in pathogenesis of proximal diverticula. A preponderance of excitatory cholinergic nerves and a diminution of action of non-adrenergic, non-cholinergic inhibitory nerves by nitric oxide have been noted in diverticular colons compared with controls. These findings suggest that an imbalance in usual excitatory and inhibitory influences could favour enhanced tonicity.

Whether altered motility and intraluminal hypertension are a cause of disease or symptoms, or an effect of same, is uncertain.

Dietary fibre
The geographic variability of diverticular disease and correlation with a western diet have long suggested a dietary factor as fundamental in pathogenesis of the disorder. Burkitt and Painter were the most eloquent proponents of this theory, labelling diverticulosis a deficiency disease that, like scurvy, could be avoided with dietary changes. They recorded transit times and stool weights from more than 1200 individuals in the UK and rural Uganda. The UK patients, eating a low fibre diet, had transit times of about 80 h and mean stool weights of 110 g/day. By contrast, rural Ugandans, eating very high fibre diets, had times of 34 h and weights of more than 450 g/day. The longer transit time and smaller stool volumes were thought to increase intraluminal pressure, predisposing to diverticular herniation. As reasonable as this hypothesis seems, the results of studies in western populations comparing transit times and stool volumes in patients with and without diverticular disease have failed to show significant differences. Nonetheless, corroborative data in animals do exist, most notably in rats fed diets of various fibre content throughout their lifespan. 45% of rats on the lowest fibre diet developed diverticula compared with only 9% of those fed the highest fibre diet. Furthermore, in another animal model, high fibre diets protected against collagen crosslinking and were associated with reduced frequency of diverticulosis.

Uncomplicated diverticulosis
Most patients, perhaps 75–80%, with anatomical diverticulosis will remain asymptomatic throughout their lifetime. Of the few who develop complications, diverticulitis—and its difficulties such as abscesses, fistulas, or obstruction—is the most usual manifestation, followed by diverticular haemorrhage, both of which are addressed below.

The asymptomatic patient
Asymptomatic diverticular disease is frequently an incidental finding during assessment of a patient for another reason, such as routine screening for colon cancer. No treatment or follow-up needs to be offered to this large population, most of whom will remain asymptomatic, although findings of one study suggested a possible prophylactic benefit of a high-fibre diet. In a
A prospective study of 51,529 US male health professionals followed up for more than 4 years, 385 new cases of symptomatic diverticular disease were identified. A significant inverse association was recorded between dietary fibre intake and risk of development of clinically evident diverticular disease. Insoluble fibre from fruits and vegetables was noted to be more protective than cereal fibres. These results provide support for a recommendation that patients with asymptomatic diverticular disease might benefit from increasing their fruit and vegetable fibre intake, a stance endorsed by the American Dietetic Association. The symptomatic patient

Patients can present with non-specific abdominal complaints—eg, lower abdominal pain, usually left-sided—and subsequently be shown to have diverticulosis coli; a causal relation is sometimes difficult to establish. Such patients do not usually manifest signs of inflammation, such as pyrexia or neutrophilia, which could indicate diverticulitis. Pain is generally exacerbated by eating and diminished with defecation or flatus, which suggests colonic wall tension due to raised intraluminal pressure. Patients might also report other symptoms such as bloating or constipation. Assessment can indicate fullness or mild tenderness in the left lower quadrant, but frank rebound or guarding should be absent. A guaiac-positive stool in this setting should never be attributed to diverticulosis without complete colonic assessment. Findings of laboratory studies should be normal.

Diagnostic modalities

For years, barium enema was the standard investigation in diverticulosis patients, and although it provides information on number and location of colonic diverticula, it cannot discern clinical relevance. However, inaccurate findings have been reported in nearly a third of patients with diverticulosis. This disorder has, in the past, been regarded as a contraindication to colonoscopy.34 Findings of laboratory studies should be attributed to diverticulosis without complete colonic assessment. Findings of laboratory studies should be normal.

Complicated diverticular disease

Diverticulitis

Diverticulitis is the most usual clinical complication of diverticular disease, affecting 10–25% of patients with diverticula. The process by which diverticulitis arises has been likened to that of appendicitis, with a diverticulum becoming obstructed by inspissated stool in its neck. This faecalith abrades the mucosa of the sac, causing inflammation and expansion of usual bacterial flora, with diminished venous outflow and localised ischaemia. Bacteria may breach the mucosa and extend the process through the full wall thickness, ultimately leading to perforation. Extent and localisation of the perforation will establish its clinical behaviour. Microperforations can remain contained by pericolic fat and mesentery and cause small pericolic abscesses. Large perforations can result in an extensive abscess, which could continue around the bowel wall and form a large inflammatory mass or extend to other organs. Free perforation into the peritoneum causing frank peritonitis can be life-threatening but is rare.

Clinical features

People with diverticulitis generally present with left lower quadrant pain, indicating the propensity for this disorder to arise in the sigmoid colon.42 Although individuals with redundant sigmoid colons can manifest suprapubic or right-sided pain, Asian patients have predominantly right-sided diverticula and will usually present with right lower quadrant pain.42 Pain may be intermittent or constant and is sometimes associated with a change in bowel habits. Haematochezia is rare, although anorexia, nausea, and vomiting can arise. Physical examination usually discloses localised tenderness and, occasionally, a palpable mass. Bowel sounds are typically depressed but can be normal in mild cases or enhanced in the presence of obstruction. Rectal examination may reveal tenderness or a mass, especially with a low-lying pelvic abscess. Fever is present in most patients, although hypotension and shock are unusual. White blood cell count is sometimes raised.

The differential diagnosis of this presentation includes acute appendicitis, especially in Asian patients or those with redundant sigmoid colons. Aphthous ulcers, anorectal involvement, and chronic diarrhoea suggest a possible diagnosis of Crohn’s colitis. Colon carcinoma, like diverticulosis, affects colons of ageing westerners, and a causal relation has been postulated. Most probably, colon cancer and diverticulosis are both results of the same environmental effects, mainly dietary. Chronic symptoms of weight loss or bleeding should raise suspicion for carcinoma. Surgical investigation and resection could be necessary to make a precise diagnosis. In uncomplicated cases, elective colonoscopy after acute inflammation has resolved will allow for exclusion of malignant disease. Elderly people with diverticulosis are also at risk for ischaemic colitis. Features helpful to differentiate between these disorders include presence of thumbprinting on abdominal radiographs and haematochezia, both suggesting ischaemia. Gynaecological disorders, such as ruptured ovarian cysts, ovarian torsion, ectopic pregnancy, or pelvic inflammatory disease, can resemble acute diverticulitis in female patients. Pelvic ultrasound can be helpful in obtaining an accurate diagnosis. Other forms of colitis, such as pseudomembranous or amoebic, can also mimic diverticulitis.

Diagnostic modalities

Most patients with diverticulitis present with signs and symptoms sufficient to justify clinical diagnosis and treatment.
institute empiric treatment, although a thorough physical examination and basic laboratory studies, such as white blood cell count, should be done in patients coming to clinical attention. Further studies should be reserved for individuals in whom diagnosis remains uncertain, response to empiric treatment is suboptimal, or a complication is suspected.

Chest and abdominal radiographs should generally be done in patients with clinically significant abdominal pain. A chest radiograph taken while the patient is upright can aid detection of pneumoperitoneum and help to assess cardiopulmonary status. Abdominal radiographs can show abnormal findings in 30–50% of patients, which include small or large bowel dilation or ileus, pneumoperitoneum, bowel obstruction, or soft-tissue densities suggesting abscesses.

Contrast enemas—once the diagnostic standard—are limited by the fact that diverticulitis is mainly an extraluminal process. If they are to be undertaken, water-soluble contrast material should be used and a low-pressure single-contrast study done. Findings deemed highly suggestive of diverticulitis include extravasated contrast material outlining an abscess cavity, intramural sinus tract, or fistula (figure 2). Absence of any diverticula should provoke reconsideration of the diagnosis. In retrospective analyses, contrast enema has been shown to have a sensitivity of 62–94%, with false-negative results in 2–15%.

CT scanning has an increasing role in diagnosis, and should be regarded as the diagnostic procedure of choice. Abdominal and pelvic scanning is done with intravenous, oral, and rectal contrast. Criteria suggestive of diverticulitis include pericolic infiltration of fatty tissue, colonic wall thickening, and abscess formation (figure 3). In many trials comparing CT with barium enema in suspected diverticulitis, sensitivities for CT of 93–98% and specificities of 75–100% have been consistently reported, significantly more accurate than contrast enemas.

Because of risk of perforation from either the device or air insufflation, endoscopy is generally avoided in initial assessment of the patient with acute diverticulitis. Its use should be restricted to situations in which diagnosis of diverticulitis is unclear. In such cases, limited sigmoidoscopy with minimum insufflation can be helpful to exclude other diagnoses, such as inflammatory, infectious, or ischaemic colitis.

**Treatment**

Need for admission is the initial decision to be made in uncomplicated diverticulitis, which is based on patient’s presentation, their ability to tolerate oral intake, severity of illness, comorbid disease, and adequate outpatient support. Outpatients should be treated with a clear liquid diet and a broad-spectrum oral antibiotic with activity against anaerobes and gram-negative rods (in particular, *Escherichia coli* and *Bacteroides fragilis*). Symptomatic improvement should generally be evident within 2–3 days, at which time diet can be slowly advanced. Antibiotic treatment should be continued for 7–10 days. Patients needing admission should have clear liquids or nothing by mouth and intravenous fluids. Intravenous antibiotics should be started, aimed mainly at colonic anaerobic and gram-negative flora. Improvement of symptoms should
be expected within 2–4 days, at which point diet can be advanced. If improvement continues, patients may be discharged to complete a 7–10 day oral antibiotic course. Failure of conservative medical treatment warrants a diligent search for complications, consideration of alternative diagnoses, and surgical consultation. Most patients admitted with acute diverticulitis will respond to conservative treatment, but 15–30% will need surgery during that time.48,53 Free perforation with generalised peritonitis, although uncommon, carries a high mortality rate (up to 35%) and needs urgent surgical intervention.4,60

For most patients who respond well to conservative treatment, an important clinical question subsequently revolves around likelihood of recurrence and role of prophylactic surgical resection. Risk of recurrent symptoms after an attack of acute diverticulitis has been reported between 7% and 45%; a third is a reasonable approximation.4,54 Recurrent attacks are less likely to respond to medical treatment and have a high mortality rate;9,63 thus, most authorities agree that elective resection is indicated after two attacks of uncomplicated diverticulitis.59–61 The risk-benefit analysis of such an approach must be tailored with consideration of severity and responsiveness of the episode, general health of the patient, and risk of subsequent occurrence. Risk of resection is an evolving factor, with reports of increasingly favourable experiences with laparoscopic resections for diverticular disease.57–62 This approach might reduce the threshold for resection in some patients by lowering operative morbidity. However, some patients will still have symptoms after surgical resection.

Diverticulitis in special situations

Diverticulitis is seen in about 2–5% of people younger than 40 years old.4,55 mainly in males.4,63,64 Disease is more virulent in young patients, with 66–88% needing urgent surgery during their initial attack, with a high risk of recurrences or complications.4,9,53,64 Obesity can also be an important risk factor in young people.51 For these reasons, and because of the low operative risk of an elective procedure in an otherwise healthy young patient, resection is generally indicated after one well-documented episode of uncomplicated diverticulitis.45,54 Others, however, have questioned this assertion.56,69,83 Immunocompromised patients with diverticulitis may present with more subtle signs and symptoms than those who are immunocompetent and represent a difficult diagnostic challenge. They are less likely to benefit from medical treatment and have a higher rate of free perforation, need for surgery, and postoperative mortality than non-compromised patients.28,71 Because of this high risk, some authorities have advocated elective resection after one episode in an immunosuppressed individual.9

Complicated diverticulitis

Abscess

When perforation of a diverticulum takes place, a localised phlegmon initially develops; further spread can lead to formation of large local or distant abscesses. Clinical signs suggesting abscess formation include a tender mass on physical examination or persistent fever despite an adequate trial of antibiotics. When an abscess is suspected, CT scanning is the best modality for making the diagnosis and following its course.

Small pericolic abscesses can generally be treated conservatively with continued antibiotics and bowel rest.49,72 In patients in whom surgery is needed, a single-stage resection and anastomosis can generally be done. For those with distant or unresolved abscesses, drainage is indicated. Surgery was previously the main option, but CT-guided percutaneous drainage of abdominal abscesses is now used in preference when feasible. The advantage of percutaneous catheter drainage is rapid control of sepsis and patient stabilisation. Further, drainage might eliminate need for a two-stage procedure with interval colostomy, instead allowing temporary palliative drainage and subsequent single-stage resection.73–75

Fistulas

When a diverticular phlegmon or abscess extends or ruptures into an adjacent organ, fistulas can arise, the most typical being colovesical.59 Such fistulas have a two to one male predominance, attributable to protection of the bladder by the uterus and 50% rate of hysterectomy in female patients with colovesical fistulas. Pneumaturia and faecaluria are suggestive signs.67 Cystoscopy, cystography, and contrast radiographs or methylene blue studies can show fistula tracts. Single-stage operative resection with fistula closure can be undertaken in most patients.76,77 Colovaginal fistulas are the next most frequent, representing about 25% of all cases.77 Passage of stool or flatus via the vagina is pathognomonic. Frequent vaginal infections or copious discharge should prompt consideration of a colovaginal fistula. Treatment is surgical resection of the diseased colon with repair of the contiguous organ.56 Coloenteric, colourouterine, colourutereral, and colocutaneous fistulas arise much less typically.

Obstruction

During an episode of acute diverticulitis, partial colonic obstruction can happen because of relative luminal narrowing from pericolic inflammation or compression from abscess formation. Colonic pseudo-obstruction can also take place. Acute diverticulitis might cause small bowel obstruction or ileus if a loop of small intestine becomes incorporated into the inflammatory mass. These presentations usually improve as inflammation subsides with effective treatment; failure to do so should prompt surgical consultation.

Recurrent episodes of diverticulitis, sometimes subclinical, can initiate progressive fibrosis and strictureing of the colonic wall without persisting inflammation. Ultimately, high-grade or complete obstruction can happen, needing surgery. An insidious presentation with non-specific symptoms is typical. Generally, a stricture with uncertain cause is identified on barium enema. The important issue is to distinguish between a diverticular stricture and a stenosing neoplasm. Doctors should attempt to make this differentiation by colonoscopy with biopsy, but this procedure is not always possible.78 Strictures in which malignant disease cannot be excluded should undergo surgical en bloc resection. A trial of endoscopic treatment with balloon dilation can be attempted in patients in whom neoplasm is judged sufficiently excluded.69,70 Early work with colonic metal stents has suggested that they might have a role in colonic obstruction due to diverticular disease. Stenting can provide temporary decompression, allowing for bowel preparation and subsequent single-stage resection without diversion.81,82

Haemorrhage

Important lower gastrointestinal bleeding can be caused by diverticula, vascular ectasias, colitis, or neoplasms.20,49,53 Diverticular sources have been reported to be the most typically identified cause, accounting for greater than 40% of lower gastrointestinal bleeding episodes.49,57 Severe haemorrhage can arise in 3–5% of patients with diverticulosis,10,88,90 Despite the fact that most diverticula...
Pathophysiology
Microangiography on resected specimens from patients with bleeding diverticula shows intimal thickening and medial thinning of the vasa recta as it courses over the dome of the diverticulum. These changes arise asymmetrically towards the lumen and lead to segmental weakening of the artery, predisposing to rupture. Factors that initiate this arterial change are unknown, although inflammation does not seem to be a contributing factor. This finding accords with the clinical impression that bleeding rarely complicates diverticulitis.

The association of use of non-steroidal anti-inflammatory drugs (NSAIDs) with ulcer disease and upper gastrointestinal bleeding is well documented, but data have also implicated these drugs in diverticular bleeding. In a large prospective series of patients with lower gastrointestinal bleeding (in whom 50% were diverticular), a bleeding risk with NSAIDs was reported that was equal to that of duodenal ulcer. In the Health Professionals Follow-up Study, regular NSAID use was associated with raised risk of diverticular bleeding. Whether patients with diverticulosis should be counselled to avoid NSAIDs—as is done for ulcer patients—or use COX2 selective agents—is still conjecture.

Clinical features
Clinical presentation of diverticular haemorrhage is usually one of an abrupt painless onset. The patient can have mild lower abdominal cramps or the urge to defecate, followed by passage of voluminous red or maroon blood or clots. While melaena can sometimes happen with a slowly bleeding right colon lesion, the arterial nature of diverticular bleeding makes this presentation uncommon. Presence of colonic diverticula should not be judged an adequate explanation for a positive faecal occult blood test or as a cause of iron deficiency anaemia. Haemorrhage ceases spontaneously in 70–80% of patients, and rebleeding rates range from 22% to 38%. The chance of a third bleeding episode can be as high as 50%, leading many doctors to recommend surgical resection after a second bleeding episode, similar to recommendations made for recurrent diverticulitis.

Diagnosis and management
Overall management of lower gastrointestinal bleeding is beyond the scope of this review, but is described in other articles. Fluid and blood product resuscitation needs immediate attention. Exclusion of an upper gastrointestinal source by endoscopy is warranted, because 10–15% of patients with haematochezia will have an upper gastrointestinal tract cause. Flexible sigmoidoscopy is an appropriate initial approach to rule out an obvious rectosigmoid lesion, and can be done either unprepared or after enema administration. If no cause is identified, further assessment with non-invasive (nuclear scintigraphy) or invasive (angiography, colonoscopy) techniques can be undertaken in an attempt to localise and treat the bleeding source.

Scintigraphy has several theoretical advantages in assessment of lower gastrointestinal bleeding. It is non-invasive and sensitive to bleeding rates as low as 0.1 mL/min. Furthermore, once labelled, red cells remain active for up to 24 h, permitting repeat imaging in the patient with intermittent bleeding. At best, however, nuclear scans provide information only about the anatomic site of bleeding, not its cause, and have no therapeutic potential. Further, accuracy of predicting the bleeding site has been questioned. In view of the high sensitivity and relative simplicity of scintigraphy, however, many centres use this method as a screening test before angiography, to keep the number of negative angiograms to a minimum and allow for selection of a specific artery for injection.

Angiography has a sensitivity for lower gastrointestinal bleeding at a rate of 0.5 mL/min, although this value is from animal work. An important use of diagnostic angiography is to identify the site of bleeding with enough accuracy to allow selective hemicolectomy, rather than empirical subtotal colectomy, although accuracy has been questioned. An additional role for angiography rests in its therapeutic potential. Intra-arterial vasopressin can control haemorrhage in more than 90% of patients. This treatment is usually only temporary, however, because up to half of treated people will rebleed with discontinuation of infusion. Nonetheless, even temporary control of bleeding can allow semielective surgical procedure in a well-prepared patient, rather than emergency resection, with concomitant reduction in surgical morbidity. Angiographic embolisation of very distal bleeding branches (subselective) is also effective and safe.

For most patients, diverticular bleeding is self-limited. Subsequent colonoscopy should be done to elucidate the bleeding source and to exclude neoplasia. The role of colonoscopy during episodes of lower gastrointestinal bleeding is being defined. A rapid oral purge with...
electrolyte solution to prepare the colon for emergent colonic resection (figure 4). In a cohort of 48 patients with lower gastrointestinal bleeding, ten had definite signs of diverticular haemorrhage and were treated endoscopically, and none had recurrent bleeding. In a historical control group of 17 patients not treated with colonoscopy, nine had additional bleeding. Although such treatment may be applicable to only a few patients with lower intestinal bleeding, colonoscopic haemostasis will probably have an increasing role in the future.

Surgery in lower gastrointestinal bleeding is usually reserved until endoscopic or angiographic treatments fail. Segmental resection is most usually done if the bleeding site is clearly identified from a therapeutically unsuccessful angiographic or endoscopic procedure. Rebleeding is seen in about 6% of patients. In people with persistent bleeding and no angiographic or endoscopic identification of a definite bleeding site, subtotal colectomy could be needed.

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None declared.

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References


