Appendectomy: A Simple Trainee Procedure?

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Introduction

Normal anatomy of the appendix is well documented and appendectomy for appendicitis is viewed as a simple operation ideal for surgical trainees. Despite known common variations in position this operation can be challenging even for the experienced surgeon, especially when inflammation and adherence to surrounding structures has occurred. In addition there are documented cases (described below) where the anatomy is completely different to that expected. It is imperative that surgeons are aware of these variations in order to correctly diagnose and safely manage this common condition.

With many centers now using laparoscopy as the primary method of laparotomy, this can lead to negative laparoscopies and normal appendicectomies.

Normal Anatomy of the Appendix

The vermiform (wormlike) appendix is formed at the distal termination of the cecum or terminal ileum. It is a blind ending tube or diverticulum approximately 6-10 cm long [1,2]. Arterial supply to the appendix is via the appendicular artery, a branch of the ileocolic artery which in turn is a branch of the superior mesenteric artery. The venous drainage is via the ileocolic vein which drains into the superior mesenteric vein. Lymphatic vessels from the appendix drain to lymph nodes in the meso-appendix and from here to the ilecocolic lymph nodes before draining to the superior mesenteric lymph nodes. The base of the appendix is relatively consistent in position but the rest is highly variable [3,4]. Common variations in the position of the appendix include retro-caecal (58%-67%) [1,2,5], pelvic (32%), sub-caecal (2%), pre-ileal (1%) and post-ileal (0.5%).

Clinical presentation of appendicitis is commonly with pain at a point two thirds laterally along a line drawn from the umbilicus to the anterior superior iliac spine on the right side (McBurneys point). In reality the diagnosis is often more complex especially in females of reproductive age, as this can cause problems for the unwitting surgeon.

Approach to the Appendix

Traditionally appendectomy was performed via an open technique with an incision over McBurneys point - McBurneys incision. This involved dissecting down through the layers of the anterior abdominal wall (camper fascia, scarpa fascia, external oblique, internal oblique, transversus abdominus, transversalis fascia and parietal peritoneum). Many surgeons now prefer the laparoscopic approach due to the ability to look for other pathology if the diagnosis is uncertain. Port positions can vary but the most commonly used positions are 10 mm sub-umbilical camera port, 5 mm supra-pubic port and 5/10 mm left iliac fossa port.

The following will describe variations in anatomy of the appendix and how this can cause problems for the unwitting surgeon.

Vascularity

Studies as far back as 1905 have described the vascularity of the appendix Kelly and Hurdon [6] described that in 66% of cases a main appendicular artery supplied the distal 3/4 of the appendix with an accessory artery supplying the remainder. This correlates with Solankes’ [7] study in Nigerians which showed 80% had an accessory appendicular artery. Shah and Shah [8] found that in 30% of the appendix received two branches from the caecal arteries. Other studies have shown that the appendix is supplied by one branch from the ileocolic artery [9,10]. This demonstrates the variability of the blood supply to the appendix and the importance of careful dissection and identification of the main arteries in order to provide adequate haemostasis and prevent haemorrhage especially in laparoscopic surgery where presence of blood drastically reduces light through the peritoneum.

Retro-caecal Appendicitis

The most common position for the appendix is retro-caecal (58%-67%) [1-3,5]. When inflammation ascends in the retro-caecal plane diagnosis can be difficult and presentation can be confused with pyelonephritis or cholecystitis. If diagnosis is delayed or missed abscesses can form [11]. Ong [12] reported 4 cases of retro-caecal appendicitis all of which had either a sub-hepatic collection or abscess formation, one case required hemi-colectomy. Kim et al. [13] performed a retrospective analysis of CT scans in surgically proven cases of ascending retro-caecal appendicitis and found that in 70% of cases CT completely visualised the ascending retro-caecal inflammation. This suggests CT can be useful for diagnosis and extension of disease especially in atypical presentations. This will help to obtain early diagnosis, avoid unnecessary operations (cholecystectomy) and plan appendicectomy with the appropriate operating surgeon. Ascending inflammation may require mobilisation of the colon and therefore senior surgeons should be performing this procedure in order to avoid iatrogenic injury.

Sub-hepatic Appendicitis

In 1955, King [14] reported one of the first known cases of sub-hepatic appendicitis due to non-descent of the caecum, since this a handful of case reports have described this rare anomaly [15,16]. Some report intestinal mal-rotation rather than non-descent of the caecum...
as a cause of this anatomical variant [17,18]. Sub-hepatic appendicitis does not present in the classical way and as such can be mistaken for biliary pathology. In many circumstances it runs a chronic course with ill-defined right flank and right upper quadrant pain, diagnosis is often made at laparoscopy. Perforation and abscess formation [17,18] are a significant complication due to late diagnosis. In contrast to the young patients that appendicitis normally affects sub-hepatic appendicitis presents more often in the elderly adding further uncertainty to the diagnosis [19]. Palanivelu et al. [20] reported the incidence of sub-hepatic appendix at 0.08% from their study of 7210 patients. When it comes to imaging some studies suggest that a sub-hepatic appendix with a facocolith may present on ultrasound like a gallstone [15]. Due to the delayed diagnosis and chronic inflammation that ensues with the complications of abscesses and collections this is again a presentation of appendicitis that is unsuitable for the junior surgical trainee.

Complications of Inflammation

Due to the intimate relationship of the appendix base with the caecal perforation of the base can lead to caecal contents spilling into the abdominal cavity. Wong and Naqvi [21] present such a case. In these circumstances a decision needs to be made on whether to perform a primary closure or right hemi-colectomy. Perforated appendicitis is associated with higher mortality and presents the surgeon with intra-operative obstacles such as adhesions, free pus and ill-defined anatomy. The longer a case of appendicitis goes untreated the higher the risk of perforation. Dense adhesions and chronic inflammation cause ill-defined tissue planes Hannan and Hoque [22] propose laparoscopic submucosal appendectomy to treat these difficult cases in which a "mucosal sleeve is pulled out, leaving the muscular wall. The base is then ligated flush with the cecum and divided distally, leaving the muscular tube".

Duplex Appendix

At operation whether performed open or laparoscopically a finding of an inflamed appendix usually confirms the diagnosis and cures the patient of their pain and sickness.

![Figure 1: Cave-Wallbridge classification system. Type A: Single caecum with various degrees of partial duplication. Type B1: Two appendices are symmetrically placed on either side of the ileocecal valve. Type B2: One appendix arises from the cecum at the usual site and a second appendix branch arises from the cecum along the lines of the taenia at various distances from the first. Type C: A double cecum each with an appendix. Type D: The horseshoe appendix in which one appendix has 2 openings into a common cecum.](Image)

Surgeons assume that the presence of McBurneys scar means the remaining appendix tissue can become inflamed causing stump appendicitis. This has been reported in a number of reports of patients who have either had an incidental finding of duplex appendix or have re-presented with appendicitis after already having an appendectomy [24-26] (Figure 1).

Absent Appendix

Agenesis of the appendix is estimated at 1/100,000 laparotomies performed for suspected appendicitis [27,28]. In one reported case [27], a patient presented with classical signs of appendicitis but at operation was found to have an absent appendix with another pathology causing the RIF pain (mesenteric adenitis). Another cadaveric case report [28] described a tubercle where the appendix should have been and Cserni [29] reported atresia of the ileocecal junction and appendix. It is imperative in these circumstances that a thorough exploration of the RIF is performed before confirmation of appendicular agenesis as this is a very rare condition. Thought needs to be given to all other possible locations of the appendix and other pathologies before giving an alternative diagnosis.

Left Sided Appendicitis

During embryonic development the midgut rotates anti-clockwise from its midline position to settle in its anatomically correct location. In some cases none or partial rotation occurs (mal-rotation) leading to altered positions of the midgut structures. This is reported to occur in up to 1/500 [30] live births. Situs inversus totalis is an even rarer condition 1/10,000 [31] in which all the organs are reversed in location, many patients are unaware of their condition until they seek medical attention for an unrelated condition. A literature review conducted by Akbulut et al. [32] reported 95 cases of left sided appendicitis including 66 patients with situs inversus totalis, 23 with midgut mal-rotation and 3 with caecal mal-rotation. The majority of these patients presented with left lower quadrant pain. Badea [33] suggests that imaging is essential in diagnosis and management of these cases. While left sided appendicitis may be difficult to diagnose treatment is similar to its right sided counterpart and in the absence of other complications should be straightforward.

Appendix Diverticulum

Diverticular disease is normally associated with the left colon especially the sigmoid but incidences of appendix diverticulum have been reported [34-37]. As with diverticulum in other areas they can become inflamed and present in a similar fashion to appendicitis. Appendicular diverticulitis tends to present at a later age and similarly to sub-hepatic appendicitis causes diagnostic uncertainty with late diagnosis and a high incidence of perforation. Lipton et al. [34] quote more than a fourfold increase in perforation rates when compared to appendicitis, other studies [35] have quoted similar rates. Not only does perforation cause peritonitis and abscess formation but this diverticulum can form fistula with surrounding structures [38]. Furthermore Abdullgaffar [39] reports an association of appendiceal diverticulum with obstructing appendix neoplasms. In cases of fistulation expert management by a colorectal specialist may be required.

Stump Appendicitis

If a large cuff is left at the base of the appendix following an appendicectomy the remaining appendix tissue can become inflamed causing stump appendicitis. This has been reported in a number of
stump appendicitis in the English literature. Surgeons need to be aware of the balance between leaving a healthy cuff to prevent leakage and the risk of re-currant appendicitis in any remaining appendix tissue. A high index of suspicion is necessary in order to diagnose stump appendicitis and management will consist of removing the remaining appendix tissue.

Appendicitis Mimicry

As well as the aforementioned anatomical variations of the appendix a brief comment needs to be made on other pathology presenting as appendicitis. The following are reports of patients that presented as appendicitis but were found to have other pathology causing their RIF pain....

Cole et al. [43] reports the rare case of a solitary caecal diverticulum presenting with RIF pain indistinguishable from acute appendicitis.

Kamaroudis et al. [44] reports epiploic appendagitis as a cause of RIF pain the treatment of this entity is conservative.

Pogorelic et al. [45] reports torsion of an epiploic appendage as a cause for RIF pain which was subsequently excised laparoscopically with the normal appendix.

Recent Studies

A recently published multicenter observational study of 3326 appendicectomies concluded that laparoscopy was the method of operation in 66.3% of cases and that laparoscopy reduced 30 day morbidity. In addition daytime operating reduced the normal appendicectomy rate [46]. This suggests that where possible appendicectomies should be performed laparoscopically and during daylight hours this will also allow for trainees to perform the procedure with consultant assistance when needed.

Conclusion

Appendicitis is one of the most common acute surgical presentations. Appendicectomy is frequently viewed as a trainee procedure. Aberrations in vasculature, anatomical location, and anatomical variants (duplex) can cause significant difficulty and for the unwitting surgeon in diagnosis and at operation. Imaging has its place in diagnosis of atypical presentations of abdominal pain particularly in the form of CT scan but diagnostic laparoscopy allows direct visualisation of intra-abdominal pathology and progression to the appropriate operation by the appropriately trained and experienced surgeon. A combination of clinical examination, blood tests, imaging and most importantly experience are required in order to correctly diagnose and treat this common pathology.

References


