Emergency Medicine: Open Access
ISSN: 2165-7548
Ball and Findlay, Emerg Med (Los Angel) 2015, 5:3
DOI: 10.4172/2165-7548.1000253
Review Article Open Access

Appendicectomy: A Simple Trainee Procedure?

William Robert Ball* **and Laura Findlay**

Royal Stoke Hospital, UK

***Corresponding author:** William Robert Ball, MRCS, MbChB, BSC Med Sci, Royal Stoke Hospital, UK, E-mail: ballwilliam@doctors.org.uk

Received date: February 22, 2015; **Accepted date:** March 27, 2015; **Published date:** April 04, 2015

Introduction

Normal anatomy of the appendix is well documented and appendicectomy 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 removal knowledge of anatomical variations is essential for safe and optimal positioning of ports as well as thorough assessment of right iliac fossa pain.

Normal Anatomy of the Appendix

The vermiform (wormlike) appendix is formed at the condensations of the taenia coli of the caecum it is suspended from the terminal ileum by the meso-appendix which contains its blood supply. 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 ileocolic 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 child bearing age where ovarian pathology can present in a similar manner, this can lead to negative laparoscopies and normal appendicectomies.

Relations to the appendix in its “normal” position are the caecum, terminal Ileum and iliac vessels.

Approach to the Appendix

Traditionally appendicectomy was performed via and open technique with an incision over McBurneys point - McBurneys incision. This involved dissecting down through the layers of the anterior abdominal wall (campers fascia, scarpas 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.

Vasculature

Studies as far back as 1905 have described the vasculature 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 cases 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 absorption.

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 faecolith 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 caecum 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.

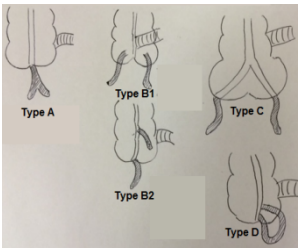

Figure 1: Cave-Wallbridge classification system. Type A: Single caecum with various degrees of partial duplication. Type B1: Two appendices are symmetrically placed on either side of the ileocecal valve. Type B2: One appendix arises from the cecum at the usual site and a second appendix branches from 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.

Surgeons assume that the presence of McBurneys scar means the patient has no appendix and alternative diagnoses are sought for right iliac fossa (RIF) pain. Although rare (0.004-0.009%) [23] there are case reports of patients who have either had an incidental finding of duplex appendix or have re-presented with appendicitis after already having an appendicectomy [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

studies [40,41] including Roberts et al. [42] who identified 48 cases 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 form acute appendicitis

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

Pogorelić 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

1. Fashina IB, Adesanya AA, Atoyebi OA, Osinowo OO, Atimomo CJ (2009) Acute appendicitis in Lagos: a review of 250 cases. Niger Postgrad Med J 16: 268-273.
2. Bakheit MA, Warille AA (1999) Anomalies of the vermiform appendix and prevalence of acute appendicitis in Khartoum. East Afr Med J 76: 338-340.
3. Moore K, Dalley A (1999) Clinically Oriented Anatomy (4th edn), Canada: Lippincott Williams and Wilkins.
4. Drake R, Vogl W, Mitchell A (2005) Grays Anatomy for Students. 1st ed. Canada: Churchill Livingstone.
5. Clegg-Lamptey JN, Armah H, Naaeder SB, Adu-Aryee NA (2006) Position and susceptibility to inflammation of vermiform appendix in Accra, Ghana. East Afr Med J 83: 670-673.
6. Kelly HA, Hurdon E (1905) The Vermiform Appendix and Its Diseases. Philadelphia, W.B. Saunders, 189.
7. Solanke TF (1968) The blood supply of the vermiform appendix in Nigerians. J Anat 102: 353-361.
8. SHAH MA, SHAH M (1946) The arterial supply of the vermiform appendix. Anat Rec 95: 457-460.
9. Bruce J, Walmsley R, Ross JA (1964) Manual of Surgical Anatomy. Edinburgh, London, E & S Livingstone 377.
10. Pityski K, Skawina A, Gorczyca J, KitliÅ„ski M, KitliÅ„ski Z (1992) Arterial vascularization of the vermiform appendix in human fetus. Folia Morphol (Warsz) 51: 159-164.
11. Fanning DM, Barry M, O'Brien GC, Leahy AL (2007) Perforation of a retrocaecal appendix presenting clinically as a right lumbar abscess. Surgeon 5: 368-370.
12. Ong EM, Venkatesh SK (2009) Ascending retrocecal appendicitis presenting with right upper abdominal pain: utility of computed tomography. World J Gastroenterol 15: 3576-3579.
13. Kim S, Lim HK, Lee JY, Lee J, Kim MJ, et al. (2006) Ascending retrocecal appendicitis: clinical and computed tomographic findings. J Comput Assist Tomogr 30: 772-776.
14. KING A (1955) Subhepatic appendicitis. AMA Arch Surg 71: 265-267.
15. Isreb S, Holtham S (2010) Incidental finding of an anterior sub-hepatic appendix during laparoscopic cholecystectomy. BMJ Case Rep 2010.
16. Montes-Tapia F, Quiroga-Garza A, Abrego-Moya V (2009) Primary torsion of the vermiform appendix and undescended cecum treated by video-assisted transumbilical appendectomy. J Laparoendosc Adv Surg Tech A 19: 839-841.
17. Galvan-Montano A, Flores-Nava G, Suarez-Roa Mde L, Salazar-Herrera MC, Lavalle-Villalobos A (2010) Subhepatic appendicitis with subdiaphragmatic abscess in a pediatric patient without intestinal malrotation: case report. 78: 79-81.
18. Rappaport WD, Warneke JA (1989) Subhepatic appendicitis. Am Fam Physician 39: 146-148.
19. Ting JY, Farley R (2008) Subhepatically located appendicitis due to adhesions: a case report. J Med Case Rep 2: 339.
20. Palanivelu C, Rangarajan M, John SJ, Senthilkumar R, Madhankumar MV (2007) Laparoscopic appendectomy for appendicitis in uncommon situations: the advantages of a tailored approach. Singapore Med J 48: 737-740.
21. Wong CS, Naqvi SA (2011) Appendicular perforation at the base of the caecum, a rare operative challenge in acute appendicitis, a literature review. World J Emerg Surg 6: 36.
22. Hannan J, Hoque M (2012) Laparoscopic submucosal appendectomy for difficult and adherent cases: a novel technique to minimize complications. J Laparoendosc Adv Surg Tech A 22: 1017-1020.
23. COLLINS DC (1955) A study of 50,000 specimens of the human vermiform appendix. Surg Gynecol Obstet 101: 437-445.
24. Varshney M, Shahid M, Maheshwari V, Mubeen A, Gaur K (2011) Duplication of appendix: an accidental finding. BMJ Case Rep 2011.
25. Travis JR, Weppner JL, Paugh JC 2nd (2008) Duplex vermiform appendix: case report of a ruptured second appendix. J Pediatr Surg 43: 1726-1728.
26. Sani R, Harouna Y, Hama Y, Nouhou H, Faucheron JL (2010) First case of double appendicitis complicating duplication of a vermiform appendix in an adult patient. Colorectal Dis 12: 1162-1163.
27. Zetina-Mejía CA, Alvarez-Cosío JE, Quillo-Olvera J (2009) Congenital absence of the cecal appendix. Case report. Cir Cir 77: 407-410.
28. Sarkar A1 (2012) Congenital absence of the vermiform appendix. Singapore Med J 53: e189-191.
29. Cserni T, Magyar A, Németh T, Paran TS, Csízy I, et al. (2006) Atresia of the ileocecal junction with agenesis of the ileocecal valve and vermiform appendix: report of a case. Surg Today 36: 1126-1128.

30. Low SF, Ngiu CS, Sridharan R, Lee YL (2014) Midgut malrotation with congenital peritoneal band: a rare cause of small bowel obstruction in adulthood. BMJ Case Rep 2014.
31. Bajwa SJ, Kulshrestha A, Kaur J, Gupta S, Singh A, et al. (2012) The challenging aspects and successful anaesthetic management in a case of situs inversus totalis. Indian J Anaesth 56: 295-297.
32. Akbulut S, Ulku A, Senol A, Tas M, Yagmur Y (2010) Left-sided appendicitis: review of 95 published cases and a case report. World J Gastroenterol 16: 5598-5602.
33. Badea R, Al Hajjar N, Andreica V, ProcopeÅ£ B, Caraiani C, et al. (2012) Appendicitis associated with intestinal malrotation: imaging diagnosis features. Case report. Med Ultrason 14: 164-167.
34. Lipton S, Estrin J, Glasser I (1989) Diverticular disease of the appendix. Surg Gynecol Obstet 168: 13-16.
35. Yamana I, Kawamoto S, Inada K, Nagao S, Yoshida T, et al. (2012) Clinical characteristics of 12 cases of appendiceal diverticulitis: a comparison with 378 cases of acute appendicitis. Surg Today 42: 363-367.
36. Manzanares-Campillo Mdel C, Pardo-García R, Martín-Fernández J (2011) Appendicular pseudodiverticula and acute appendicitis. Our 12-year experience. Rev Esp Enferm Dig 103: 582-585.
37. Heffernan DS, Saqib N, Terry M (2009) A case of appendiceal diverticulitis, and a review of the literature. Ir J Med Sci 178: 519-521.
38. Yucel AF, Pergel A, Kocakusak A, Aydin I, Bagci P, et al. (2011) Multiple caeco-appendiceal fistulas and diverticulosis: a newly defined congenital anomaly of the appendix-report of the first case. J Gastrointest Surg 15: 2111-2113.
39. Abdullgaffar B1 (2009) Diverticulosis and diverticulitis of the appendix. Int J Surg Pathol 17: 231-237.
40. Bu-Ali O, Al-Bashir M, Samir HA, Abu-Zidan FM (2011) Stump appendicitis after laparoscopic appendectomy: case report. Ulus Travma Acil Cerrahi Derg 17: 267-268.
41. Tang XB, Qu RB, Bai YZ, Wang WL (2011) Stump appendicitis in children. J Pediatr Surg 46: 233-236.
42. Roberts KE, Starker LF, Duffy AJ, Bell RL, Bokhari J (2011) Stump appendicitis: a surgeon's dilemma. JSLS 15: 373-378.
43. Cole M, Ayantunde AA, Payne J (2009) Caecal diverticulitis presenting as acute appendicitis: a case report. World J Emerg Surg 4: 29.
44. Kambaroudis A, Papadopoulos S, Arapoglou S, Fragandreas G, AlMogrampi S, et al. (2010) Primary inflammation of an epiploic appendix of the ascending colon. Is atypical presentation a reason for emergency laparotomy? Chirurgia (Bucur) 105: 551-554.
45. Pogorelic Z, Stipic R, Druzijanic N, Perko Z, Grandic L, et al. (2011) Torsion of epiploic appendage mimic acute appendicitis. Coll Antropol 35: 1299-1302.
46. (2013) National research collaborative. Multicentre observational study of performance variation in provision and outcome of emergency appendicectomy. Br J Surg 100: 1240-52.