Flying through the colon – the development of computed tomography (CT) colonography

**Summary**
Traditionally barium enema has been the radiological alternative to colonoscopy for examining the colon. Although a good test in expert hands, barium enema has a well-documented miss rate even for colon cancer and is often poorly tolerated by patients. The Royal College of Radiologists Research Fellowship recipient, Dr Stuart Taylor and colleagues were one of the first groups in the UK to develop an alternative technique – computed tomography colonography (CTC) – sometimes called virtual colonoscopy. CTC is now the firstline radiological test of choice and will replace the barium enema over the coming years.

**Background**
Colon cancer affects 1 in 6 of the population and is the second most common cause of cancer death in the UK. If diagnosed at an early stage, colon cancer has a very high cure rate. Furthermore, up to 80% of cancers arise from small precursor polyps in the colon, which if detected and removed can prevent the disease developing. Traditionally total colonic examination required either a full colonoscopy (invasive endoscopic technique with a small but well-documented risk of complications), or a barium enema (radiological technique requiring the colon to be lined with barium solution). In the late 1990s, a new radiological alternative to barium enema called CT colonography (a CT scan of the cleansed, gas-filled colon) was being developed. The ability of computer software to reconstruct the CT data so the reader could ‘fly’ through the lumen of the colon gave the technique its alternative name of virtual colonoscopy (Figure 1).

While research in the USA was focused on use of CTC to detect asymptomatic polyps in a screening population, in the UK and Europe, the emphasis has been overwhelmingly on investigation of patients with symptoms of colorectal cancer. In the first prospective clinical studies in the UK, Dr Taylor and colleagues demonstrated CTC performed well both in patients presenting with rectal bleeding and in those referred to hospital with symptoms suspicious of colon cancer via the ‘two-week wait’ programme. At that time, the group performed a systematic review of the literature and confirmed the sensitivity of CTC for colon cancer was around 96%. On this background, the UK Department of Health, via the Health Technology Assessment (HTA) programme, commissioned research to determine the likely future role of CT colonography within the NHS – the Special Interest Group in Gastrointestial and Abdominal Radiology (SIGGAR) 1 study (principal investigator Steve Halligan). SIGGAR 1 was a randomised study recruiting over 5,000 patients comparing CTC with both barium enema and colonoscopy. Recently abstracted presentation of the results confirms the diagnostic superiority of CTC over barium enema, paving the way for replacement of barium enema with CTC across healthcare systems.

**Technical development**
In 2001, Dr Stuart Taylor, now a Reader in Medical Imaging at University College London, was awarded The Royal College of Radiologist Research Fellowship and undertook a doctorate in CT colonography supervised by Professor Steve Halligan, then at St Mark’s Hospital, Harrow. Initial work focused on technical aspects of CTC, such as optimisation of CT acquisition parameters, bowel preparation, effect of spasmyotics and rectal catheter type. Importantly, in comparative studies, Dr Taylor showed patients overwhelmingly preferred CTC over barium enema. He also demonstrated the clear need for dedicated training for radiologists interpreting the test and in 2007 published a consensus statement as to the practice of CTC on behalf of the European Society of Gastrointestinal and Abdominal Radiology.

**Clinical implementation**
While research in the USA was focused on use of CTC to detect asymptomatic polyps in a screening population, in the UK and Europe, the emphasis has been overwhelmingly on investigation of patients with symptoms of colorectal cancer. In the first prospective clinical studies in the UK, Dr Taylor and colleagues demonstrated CTC performed well both in patients presenting with rectal bleeding and in those referred to hospital with symptoms suspicious of colon cancer via the ‘two-week wait’ programme. At that time, the group performed a systematic review of the literature and confirmed the sensitivity of CTC for colon cancer was around 96%. On this background, the UK Department of Health, via the Health Technology Assessment (HTA) programme, commissioned research to determine the likely future role of CT colonography within the NHS – the Special Interest Group in Gastrointestinal and Abdominal Radiology (SIGGAR) 1 study (principal investigator Steve Halligan). SIGGAR 1 was a randomised study recruiting over 5,000 patients comparing CTC with both barium enema and colonoscopy. Recently abstracted presentation of the results confirms the diagnostic superiority of CTC over barium enema, paving the way for replacement of barium enema with CTC across healthcare systems.

**Future directions**
In more recent years, Dr Taylor has been at the forefront of research investigating computer-aided detection (CAD) software to aid radiologist interpretation of CTC datasets (Figure 2). His group has shown CAD detects colonic neoplasia at a level equivalent to expert radiologists, improves sensitivity of all readers irrespective of prior experience and is best used as a second read to check the initial interpretation of the unassisted radiologist. He has also shown high diagnostic accuracy can be maintained even when reducing the laxative burden on patients with the additional oral ‘tagging agents’ to label retained colonic contents, and that combining CTC with positron emission tomography (PET) provides a safe, well-tolerated and accurate investigation for older patients.

**References**