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1 Introduction

Computed tomographic colonography (CTC), commonly known as Virtual Colonoscopy (VC) has recently emerged as a fundamentally new technique for radiologic imaging of the colon with the unique potential for broad application in population screening for colorectal cancer. Yet, when framed in the philosophic question of “why do we do CTC?”, the analogy to Mt. Everest becomes clear. We do CTC because the technology exists.

In the early 1990s, the introduction of spiral CT scanners, and powerful new computer workstations for image processing prompted individual pioneers to exploit the new technology at least in part, because they could. Coin obtained a United States patent for CT reconstruction of the colon (COIN et al. 1995), while Vining is credited with the first clinical demonstration of what he termed ‘virtual colonoscopy’ (VINING and GELFAND 1994). Hara at the Mayo Clinic (HARA et al. 1996) and Royster at Boston University (ROYSTER et al. 1997) confirmed clinical feasibility for polyp detection. Fenlon then showed that the sensitivity of CTC equaled that of conventional colonoscopy for detection of large polyps and cancers in a landmark 100 patient Boston University study published in the New England Journal of Medicine (FENLON et al. 1999). As they say, the rest is history.

As CTC enters its second decade, it is no longer new, but retains many compelling features. Technologically it maintains its sophisticated, innovative appeal and still exhibits great potential to evolve further. Scientifically, CTC is reframing strategies for colorectal cancer screening and now challenges the primacy of colonoscopy and the specialty of gastroenterology for the diagnosis of colon disorders. At the same time, CTC has been a dominant focus of research in abdominal and gastrointestinal radiology for several years, stimulating an enormous volume of original scientific investigation as well as media and industry attention. Impressive clinical results continue to appear from investigators throughout the world, including North America, Europe, and Australia (YEE et al. 2001; MACARI et al. 2002; IANNAcone et al. 2003; EDWARDS et al. 2004). Even more important is the totally non-invasive aspect of CTC (no drugs, no contrast media and no injections) which has won the favor of many physicians and their patients, especially when compared to optical colonoscopy. In preference studies comparing the two tests, patients usually prefer CTC despite the unavoidable biases of pre-endoscopy sedation (SVENSSON 2002). It is this patient friendly, ‘compliance enhancer’ nature of CTC which has been able to attract otherwise reluctant patients to undergo colorectal cancer screening. A recent U.S. hospital think tank reported that some 60% of patients having virtual colonoscopy had never had any prior form of colorectal cancer screening (ADVISORY BOARD 2004) (Fig. 1). In the United States, several HMOs have begun to reimburse for colorectal cancer screening using CTC, and wider reimbursement coverage is expected in 2006 which should lead to rapid wide dissemination into clinical practice.
Colorectal Cancer Screening (CRCS): Rationale

Across the developed world, colorectal cancer is the second or third leading cause of cancer deaths. While a small percentage (10–20%) of colorectal cancers occur in high risk genetically predisposed patients, the majority, i.e., ca. 80% of colorectal cancers occur sporadically in otherwise low risk individuals. In the vast majority of such cases, the cancers are believed to arise from pre-existing adenomatous polyp pre-cursors in series of events that have a well characterized origin in genetic mutations with a consequent histopathologic sequence of degeneration into frank invasive cancer. However, this process is rather leisurely, requiring some 10–15 years or more and interruption of this progression by detection and removal of threatening pre-cursor adenomas by endoscopic polypectomy results in a decline of cancer related mortality by as much as 30%.

Guidelines for colorectal screening in asymptomatic populations have been developed on the basis of scientific medical evidence, by professional organizations and government agencies throughout Europe and North America. Most recommend that screening begin in asymptomatic individuals at low or average risk at age 50 years and permit several different testing strategies. These include annual screening with fecal occult blood tests, flexible sigmoidoscopy every five years, the combination of fecal occult blood and flexible sigmoidoscopy every five years, double contrast barium enema every five years or colonoscopy every ten years. However, none of these test strategies is ideal and proponents of the various strategies continue to engage in contentious debate. For example, the specific limitations of FOBT and flexible sigmoidoscopy have led to the concept of the desirability of an anatomic or structural examination of the whole colon. This has led to the emergence of colonoscopy as the de facto gold standard for colorectal screening as well as colon diagnosis generally. The more focused debate has revolved around whether colonoscopy should be offered as a universal once in a lifetime test, e.g., at age 60 or reserved for selective application when results of other preliminary screening tests are positive. In the latter case, the broader goal of colorectal cancer screening becomes the use of less invasive, less expensive tests for triage selection of patients to undergo therapeutic optical colonoscopy. (Parenthetically, the double contrast barium enema is rapidly falling out of favor in the U.S. for primary colorectal cancer screening.)

Yet, despite wide medical, public health and lay media airing as to the importance of colorectal cancer screening, the public has remained generally reluctant to undergo these tests which are perceived as unpleasant and embarrassing such that overall compliance with colorectal cancer screening rarely exceeds 30–40%. Recently in the specific instance of colonoscopy in the United States, compliance rate have increased slightly to ca.40–50%, but only in selected well insured patient groups. Moreover, manpower resources of colonoscopists are strained, at least in the United States, with long 6–12 month waiting lists for elective appointments. Thus, new alternative tests for colorectal cancer screening are needed and awaited and, along with fecal DNA testing, CTC appears a procedure whose time has come.

Colon Polyp: Natural History/Target of Screening

The progressive transformation of adenomatous polyps to invasive adenocarcinoma has been characterized as “the adenoma carcinoma sequence” (Muto 1975). However, because the prevalence of undetected cancer in an asymptomatic screening population is very low at ca.1%, colon polyp size is widely accepted as a surrogate end point for outcomes assessment in colorectal cancer screening programs. Thus, the concept of the “advanced adenoma” has been developed which is defined as an adenomatous polyp measuring 10 mm or greater.