Chapter 17

Robot-assisted Cholecystectomy

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Introduction

After being first performed by Carl Langenbuch in 1882, open cholecystectomy became the accepted means of treating symptomatic cholecystolithiasis and proved itself a safe procedure with low complication rates. Then, 20 years ago, laparoscopy kick-started a revolution in abdominal surgery that has been continued with other minimally invasive techniques. The first laparoscopic cholecystectomy was performed in 1987 by Dr. Phillipe Mouret and, because of its advantages (e.g., smaller incisions, quicker recovery time, improved cosmetic results and shorter stay in costly hospital beds), became accepted within a few years as the new standard therapy for gallstone disease. However, the technology it uses can actually be viewed as a step backward from certain perspectives. In laparoscopy, instrument manoeuvrability is limited and the seven degrees of motion freedom available in open surgery (i.e., up and down, in and out, left and right and rotate) are downgraded to the four degrees possible at laparoscopy. Endoscopic movements are in addition generally neither ergonomic nor intuitive. Moreover, the surgeons’ hands are relatively distant from the operative field while the instruments employed actually amplify natural tremor as well as reduce both tactile sense and force feedback appreciation [1–9].

In order to reduce these limitations, researchers have developed new tools that have led to the development of robotic telemanipulation systems. These systems represent a form of computer-assisted surgery utilising a “master-slave relationship” in which the surgeon is able to control the actions of the robot in real time. In this way, a range of advantages have been offered to the surgeon, including restoration of full dexterity and stereoscopic vision, increased surgeon comfort and ergonomics as well as tremor eradication and scaling opportunities [1–5, 7–11]. These may allow easier and more accurate tissue dissection. Even though robotic surgery has inherent disadvantages such as lack of tactile feedback, prolonged set-up and operating time (particularly early in a unit’s experience) as well as added expense [12, 13] and a requirement for larger operating rooms (in order to accommodate the robotic unit and cumbersome equipment), there are now many studies that demonstrate its feasibility in standard laparoscopic procedures [3, 6, 7, 9, 13–15].

History of Robotics

The term robot was first coined in 1920 as a derivative of the Czech word “robota” (meaning compulsory labour) although the term robotic did not come into popular use until 1942 when Isaac Asimov’s “Three Laws” captured the public’s imagination. Since then, the success of industrial machines has stimulated interest in applying robotics to other areas, including medicine. A “surgical robot” has been defined as a self-powered computer-controlled device that can be programmed to aid in the posi-
tioning and manipulation of surgical instruments [2, 8, 16, 17]. In other words, a computer provides the digital interface between the surgeon’s hands and the surgical instruments, thereby widening the skill and scope of surgical procedures. This new alliance has led to many innovations and possibly represents the beginning of a new era in medicine. The main objective in the development of robotic devices, however, is not to replace the surgeon but rather to help him perform difficult tasks more accurately and repetitive tasks more precisely. Recently, surgical robots have further evolved into telerobotic devices that may allow surgeons to operate at a distance from remote locations.

The first specialties to use such devices were neurosurgery (Neuromate®) and orthopaedic surgery (RoboDoc®). In Belgium in 1998, Himpens, Cadiere and colleagues made the first report of a successful clinical implementation of telerobotics in general surgery when they performed a robot-assisted laparoscopic cholecystectomy using the MONA® system (a prototype of the current Intuitive Surgical da Vinci® system) [7]. Today, clinical and experimental experience suggests that the use of robotic systems does not add specific complications and can achieve outcomes similar to those of the standard laparoscopic approach.

**System Description**

Since 2003 (after the acquisition of Computer Motion by Intuitive Surgical), of the two advanced surgical robotic systems originally developed, only the da Vinci robot remains and will thus be described exclusively here [1, 3, 8, 16–18]. This system consists of three separate parts: the surgeon console, the robotic cart and the video endoscopic unit connected by cables (Fig. 17.1).

**Surgeon Console**

The surgeon sits in a comfortable and ergonomic position at the console, remote from the patient. The console is composed of “masters” as controls, a binocular display screen, foot pedals and a keyboard. The surgeon’s hands fit into the free-moving “masters” or finger controls that are similar to joysticks. These convert the movements of the surgeon’s wrist and finger tips into electrical signals that are then translated to the computer to direct the robotic instruments in order to perform the same movements in the operative field. The digitalisation of the surgeon’s hand movements on the controls also provides the ability to eliminate physiologic tremor and produce motion scaling in