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FINE TILT TUNING OF A LAPAROSCOPIC CAMERA BY AN INTERNAL MAGNETS ACTUATION SYSTEM: TWO PORT NEPHRECTOMY EXPERIENCE ON HUMAN CADAVERS

Massimiliano Simi [1,2], Ryan Pickens, M.D.[2,3], Arianna Menciassi[1], S. Duke Herrell, M.D[2,3,4], PietroValdastri[2,4]

[1]The Biorobotics Institute of Scuola Superiore Sant'Anna, Pisa, Italy;

[2]Vanderbilt initiative in Surgical Engineering (ViSE), Nashville, Tennessee US;

[3]Vanderbilt University Medical Center, Department of Urologic Surgery Nashville, Tennessee US;

[4]Vanderbilt University, School of Engineering, Departments of Mechanical Engineering, Nashville, Tennessee US.

The magnetic coupling is a physical phenomena capable of transmitting forces across a physical barrier, thus the magnetic cameras for surgery are emerged as a promising solution having the potential to improve visualization without taking up port site space. To overcome the scarce precision and responsiveness in motion and poor tilt range, related to an external handle control, we developed a camera based on an Internal Magnets Actuation (IMA) capable to provide a robotized high precision and wide span tilt motion without the need of deforming the abdominal wall. We performed two port laparoscopic nephrectomies in fresh tissue human cadavers using the IMA-camera also comparing the tilt capabilities with a traditional magnetic camera mock-up.

The two fabricated camera prototypes, were separately inserted, anchored and moved inside the inflated abdomen. To achieve the tilt motion of the magnetic camera mock-up the external handle was pushed against the abdomen wall whereas for the IMA-camera it was activated by the push button interface without any handle motion. Tilting angles were quantified by image analysis and eventual intra-abdominal pressure changes were monitored for both cameras. A total of 5 nephrectomies using the IMA-camera on human cadaver were performed collecting quantitative outcomes.

The traditional magnetic camera required a constant pressure on the external magnetic handle to achieve an average of ±20° tilt from the horizontal position with a 7 mmHg loss of intra-abdominal pressure. The IMA-camera allowed for 75° of tilt with a resolution of ±1°, without any need to deform the abdomen. No significant image vibration, nor loss of pressure were observed. The 5 TPL nephrectomise on fresh tissue cadavers, resulting with an average abdominal thickness of 2 cm, were performed without any complication in an average of 11 min. Average number of activations of the IMA mechanism was 3, while mean number of pan movements was 4.8.

IMA results as an effective strategy to provide magnetic cameras with wide and high resolution vertical motion. This represents a concrete step forward for magnetic surgical instrumentations, since a constant pressure on the abdomen is not required anymore to tilt the device.