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Optimal dissection for transanal TME using modified CO2 insufflation and smoke extraction

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ABSTRACT

Aim:

The new approach of transanal TME is technically challenging and demands a stable field of dissection with optimal view of anatomical landmarks. We aimed to describe and demonstrate a modification of both the insufflation of carbon dioxide and smoke evacuation, in order to optimize dissection.

Method:

The comparison of standard insufflation to an AirSeal platform demonstrates a clear difference. This is shown in the accompanying video-recordings.

Results:

A more stable pneumorectum and better smoke-evacuation as well as more convenient and precise dissection was achieved with the AirSeal platform.

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Conclusion:

Using the technique outlined, the operating surgeon is able to perform the surgical dissection in a stable operating environment with increased visibility compared to the standard approach.

Indications

As surgeons continue to embrace the evolution of new techniques for better and safer resection of both tumours and benign disease processes of the rectum, it is important to share insights into further technical advances and improvements [1,2]. Recently, transanal total mesorectal excision (taTME) has been advocated as an alternative approach for safe surgical removal of mid and low rectal tumours [3,4]. Reported benefits are clearer definition of a safe, tumour-free distal margin and the ability to perform the deep pelvic dissection of the "no man's land" with greater accuracy, even in the narrow male pelvis or in obese patients. While initial single institution reports have reported encouraging short-term results, taTME remains in the early phase of wider acceptance as a more efficient approach to operating in an anatomically challenging location [5]. Standardization of the technique through sharing of experience and knowledge will further improve outcomes and allow for safe diffusion into daily surgical practice. We have encountered two notable obstacles in attaining a perfect transanal endoscopic surgical field. These have also been noted as limitations by other early adaptors of taTME (personal communication). Firstly, the current set-up as described previously results in excessive diathermy-induced smoke in an already restricted operative field [2]. Secondly, bellowing or oscillation of the rectum ("unstable pneumorectum") can be counterproductive. Here we aim to describe and demonstrate a modification in the current set-up for the perineal portion of this procedure in order to circumvent these two issues by use of the AirSeal® System. It consists of an Intelligent Flow System (iFS) control unit, one valve-less access port and one contiguous tri-lumen filter tube set. This has recently been applied and described in relation to transanal minimally invasive surgery (TAMIS) for early rectal cancer [6].

Method

Once the abdominal portion of the taTME procedure has been completed, the transanal part is performed, or vice versa, while a synchronous procedure is also feasible. With the patient in a dorsal lithotomy position, a GELPOINT® path transanal access platform (Applied Medical, Inc., Rancho Santa Margarita, CA, USA) is inserted into the anal canal. In a standard set-up three self-retaining ports are inserted through the removable gel cap. To use the AirSeal® System (SurgiQuest, Inc., Milford, CT, USA) to achieve a "pneumorectum" in taTME procedures, one of the Applied GELPOINT ports is replaced by either a 5mm, 8mm or 12mm AirSeal valve-less access port which is then connected to the tri-lumen filtered tube set. The three lumens of the filter tube set work in concert to recirculate CO2 gas into the target cavity with the provision of CO2 inflow though one lumen, outflow through a second lumen and real time monitoring and maintenance of set pressure through the third lumen. After the filter canister of the tube set is inserted into the iFS control unit, intraluminal pressure is set to an initial pressure of 8 mmHg, and the low smoke evacuation option is selected. Throughout the case the pressure can be elevated to 12-15mmHg and/or 'HIGH' smoke evacuation option can be selected if required. The set-up and differences in pelvic views achieved with and without the AirSeal® System are demonstrated in the online video (Video S1, supporting information).

Comparison with other methods, advantages and disadvantages, difficulties and complications.

Traditional laparoscopic insufflators normally toggle between CO2 gas insufflation for approximately three seconds, rest for one second to measure pressure, and then cyclically re-insufflate to maintain the "set" pressure. In laparoscopic procedures, standard mechanical insufflators cause constant and cyclical pressure fluctuation within the target cavity. This contributes to the "rectal bellowing" typically seen at operation. The small operating field and volume for circulating CO2, particularly at the start of the taTME procedure, make even small changes in pressure far more noticeable and difficult for the surgeon and assistant to manage effectively. Both the surgical smoke and bellowing interfere with operative efficiency due to constant readjustments and camera cleaning ultimately

significantly extending total procedure time. Furthermore, it can hamper correct identification of tissue planes, which can put pelvic side wall structures, nervi erigentes, and the mesorectal package at risk of damage. Control of any bleeding is also more difficult, in particular when aspiration is required to obtain an adequate view of the bleeding point.

The SurgiQuest AirSeal® System abdominal management platform responds immediately to the slightest changes in the set pressure by automatically adjusting flow rate in real time. This serves to eliminate loss of pneumorectum and loss of pneumoperitoneum as the case may be. The AirSeal® System is not new to surgery, having been successfully studied and used to good effect in intra-abdominal applications due to its ability to provide a stable pneumoperitoneum, even under constant suction/aspiration, leakage, or trocar dislodgement [7]. It therefore affords the surgeon excellent vision compared to previous insufflator devices. Due to reduced oscillation of pressure, the system results in less CO2 gas absorption by the patient with resultant benefits. Another major benefit is that of less fogging of the camera view. Because the AirSeal® System recirculates the insufflated CO2 rather than continually adding fresh, cooler CO2 there is a tendency to assimilate patients' abdominal (or pelvic in this case) ambient temperature and moisture. These aspects of design differentiate it from conventional insufflators. In particular, the recirculation of insufflated CO2 sets the Airseal platform apart from other offerings on the market.

Although a number of other high performance insufflators are now available on the market we have not trialled equipment from other major medical device manufacturers. Stryker, Olympus and Storz all have updated systems. Stryker's PneumoSure 45L insufflator gives "real time pressure sensing for increased accuracy during a procedure". It also has an updated tube set to allow higher flow. [8] The current Olympus equipment, the UHI-4 insufflation unit, offers the ability to select modes for different cavity capacities. It has an automatic smoke evacuation feature that can be enabled when coupled with a new or existing energy Olympus platform. [9] In addition, the Storz endoflator 40 provides an integrated gas heater to minimise fogging as well as electronic control providing quick

provision and stability of pneumoperitoneum or pneumorectum. The filament in their insufflation tube ensures that there is no heat loss in the tube during the insufflation process and that CO2 flows into the operative field at a steady 37 degrees Celsius. [10]

These systems help to overcome well documented limitations of previous equipment such as occasional loss of working space during suction aspiration, and inability to rapidly compensate for intra-abdominal pressure in an effective manner. We are not however, aware of any published technical notes or data in the field of colorectal surgery to allow comparison to the Airseal system.

Conventional insufflators connect with conventional trocars (Ethicon, Covidien or Applied) via a single lumen tube. There are several major limitations as a result of this relationship. CO2 can only travel in one direction into the patient causing camera fogging, build up of intra-abdominal smoke and plume, and fragmentation of tissue during specimen removal.

The AirSeal Intelligent Flow System (iFS) platform addresses these with its iFS control unit; a three lumen filter tube set which connects to 1 valveless AirSeal Trocar. One lumen of the filter tube set provides carbon dioxide inflow, one lumen provides carbon dioxide outflow and the third lumen provides real-time constant monitoring of abdominal pressure to compensate for any dynamic intra-abdominal pressure change. This has been demonstrated to reduce CO2 absorption by the patient during laparoscopic surgery. [11] Along with removing smoke, the powerful filter component of the tube set removes carcinogens and pathogens from smoke down to 0.01 microns to eliminate the hazards of surgical smoke. The valve less AirSeal Port provides the benefits of smudge free scope entry, unfragmented specimen removal along with easier insertion of clips, needles, sutures and mesh. The three alternative systems mentioned above do not have trilumen tubing as part of their platform.

The adoption of this technique therefore allows the operator to focus more on the important aspects of surgical dissection rather than being distracted by the need for continually venting smoke, loss of insufflation, pausing to clean the endoscope, and having the assistant battling to maintain an optimum view in a pneumorectum with fluctuating levels of pressure. The experience with both a standard setup for TaTME and the modified setup using the SurgiQuest AirSeal® System are shown in the video. Further details are also available online [12].

In relation to costing; the additional price of AirSeal System consumables have to be taken into account. Further technical aspects of the setup include the rigidity of the insufflation tubing hampering optimum port position in a confined space. In addition, it is important to keep the AirSeal trocar cannula in the upper part of the GELPOINT gel cap as aspiration of a large amount of fluid (particularly from irrigation) into the trocar can lead to the filter canister collecting the fluid and subsequently shutting off the control unit momentarily until the contiguous filter canister and tube set is replaced. Lastly, a 5mm or 8mm port is sufficient to achieve the desired stability and view in the pneumorectum. The use of a 12mm port has the additional flexibility of being used as a camera port if a 5mm camera is not available without interfering with overall operative performance.

A further application of the AirSeal platform is that it can be used to establish intra-abdominal pneumoperitoneum for a traditional laparoscopic set-up for a second surgical team operating synchronously from above. The advantages are similar to those mentioned previously.

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