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LAPAROSCOPIC APPENDECTOMY

FINAL REPORT

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13. ABSTRACT *(Maximum 200 words)*

Laparoscopic appendectomy is a minimally invasive endoscopic surgical procedure to remove the appendix.

From December 1990 to February 1991, Tripler Army Medical Center performed laparoscopic appendectomies on 25 patients diagnosed with acute appendicitis. Our technique uses Hulka clips across the mesoappendix, endoloop ligatures around the appendiceal base and a latex rubber bag to extract the appendix. Twenty-three of our patients had a pathologically confirmed diagnosis of acute appendicitis, with 60% of the cases categorized as suppurative, necrotic, gangrenous or perforated. One patient was switched from laparoscopic management to open laparotomy when a necrotic appendiceal base disintegrated following application of endoloops and two patients had minor complications.

Patients stayed in the hospital an average of 1.5 days, returned to work and regular activities within a week, and were generally pain-free within four to five days of the operation.

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Our early results have been extremely encouraging. Laparoscopic appendectomy appears to be a safe, cost-effective, minimally invasive surgical technique that in skilled hands may be used to remove most diseased appendices.

FOREWORD

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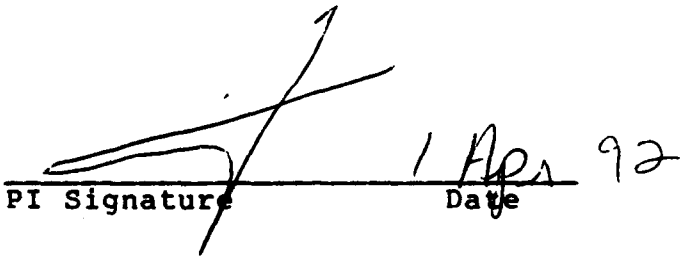

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ADDENDUM

An additional 30 laparoscopic appendectomies were performed between April 1991 and April 1992. The first 10 of these were performed using the Hulka clip, the subsequent 20 using an Endo-GIA stapler. Observations in this group were similar to those seen in the first 25. Operative time generally ranged between 30 to 75 seconds. Patients were usually discharged the following day and able to resume full duty within seven days. In the first five patients of this group there were two infectious complications. Both were intra-abdominal abscesses clearly attributable to technical error. In one case CT-directed percutaneous drainage antibiotics were needed and in the other only antibiotics. The subsequent 25 cases were performed without complications.

The Endo-GIA stapler has greatly simplified appendectomies. It has proved to be a reliable, safe instrument which decreases operative time and even facilitates performing an appendectomy when the appendix has a necrotic base, since it can be used across the cecum.

I see decreased post-operative convalescence as being the greatest benefit of laparoscopic appendectomy. Soldiers can return to full duty within one week as compared to three to four weeks. The cost-effectiveness of the Endo-GIA stapler may not be justified in the fee for service community, but the time lost from work is of significance.

Acute appendicitis is the most common cause of an acute abdomen requiring surgical intervention [1]. Management of this disease process has traditionally involved the surgical removal of the appendix through a right lower quadrant (RLQ) abdominal incision. Over the past 25 years the approach to many surgical problems has become less invasive with endoscopic methods replacing the more conventional operations performed through a laparotomy incision. An example is laparoscopic appendectomy, first described in 1982 by Semm, a German gynecologist [2]. Since then a few individuals have described other laparoscopic approaches to effect removal of the appendix [3-6]. As with laparoscopic cholecystectomies, this surgical approach has distinct advantages over the traditional appendectomy. Benefits include decrease in postoperative pain, length of hospitalization and convalescence. So far there have been no published series of laparoscopic appendectomies performed within the United States. We join Semm, Schreibner, Gotz, Gangal and Leahy from Germany, India and Canada, respectively, in reporting our early experience with laparoscopic appendectomy.

TECHNIQUE

We used a three puncture technique utilizing a 7 mm RLQ abdominal sheath and two 10 mm sheaths introduced through the umbilicus and suprapubic region. The laparoscope with attached video camera is placed through the umbilical sheath, and all 5 mm instruments are inserted through the suprapubic sheath using the appendix extractor as a sheath reducer. Through the 7 mm sheath a Palmer ovarian grasping forcep is introduced and used to grasp and change the position of the appendix while maintaining the mesoappendix on traction. It is desirable to be able to look at the broad surface of the mesoappendix rather than directly end on to allow full visualization of tissue and clips during transection of the mesoappendix. In order to facilitate the best exposure, it may become advantageous to change the position of the laparoscope back and forth from the umbilical sheath to the suprapubic sheath at different times during the procedure. The appendix may be grasped using the Palmer forceps through either the supra-pubic or RLQ abdominal sheath. With the mesoappendix on stretch, a series of Hulka clips are applied across it (occasionally bipolar cautery is also used) in a stepwise fashion using scissors to transect the tissue as each clip is placed until reaching the appendiceal base. When necessary to insert the Hulka clip applied through a 10 mm sheath, an 8 mm sheath is used as a reducing sleeve. At this point, the appendix is free of its mesoappendix and ready for ligation, transection, and extraction. An endoloop is loaded into an endoloop inducer which is inserted through a 10 mm sheath using the appendix extractor

once again as a sleeve reducer. The loop is opened in the peritoneal cavity and passed around the Palmer grasper that is inserted through the 7 mm sheath. The Palmer forcep is used to grasp the tip of the appendix and place it on tension. The loop is then slid over the appendix down to its cecal origin where it is ligated. The same maneuver is performed as two other loops are applied; one is placed 2-3 mm distal to the first and the other 1 cm distal to the second ligature placed. The excess suture of the first two endoloops is cut with scissors as they are placed, while that of the third is left intact to be used for traction. The appendix is held on tension by this suture, while it is transected by hooked scissors between the second and third loop ligatures. The suture of the third endoloop is then used to pull the appendix into the appendix extractor for removal. In the event the appendix is too large to fit through the appendix extractor or sheath, it can be brought up through the abdominal wall in a latex rubber bag without contaminating the wounds. This maneuver is accomplished by passing a 10 cm long latex rubber sleeve (7/8" penrose drain) over the end of an alligator grasper that has been passed through an appendix extractor. The rubber sleeve is wrapped around the grasper which is partially withdrawn into an appendix extractor. Both instruments are inserted together through the 10 mm suprapubic sheath. The alligator graspers are advanced out of the extractor and used to grasp a fourth endoloop ligature applied to the end of the appendix. Using this method, the appendix is transected at this time between the second and third endoloops. Another grasper is inserted through the 7 mm sheath and used to pull the end of the latex rubber sleeve over the appendix. A fifth endoloop is placed around one end of the rubber sleeve to create the "appendix bag." The open end of the rubber sleeve is grasped and partially withdrawn into the appendix extractor. The grasper, appendix extractor, 10 mm sheath and open end of the appendix bag are simultaneously withdrawn from the abdominal wall. As tension is maintained on the bag, a closed Kelly clamp is passed along it under direct vision of the laparoscope. The Kelly clamp is then opened and withdrawn in order to stretch the fascia to allow easy passage of the appendix bag. Puncture sites are injected with 0.5% Marcaine anesthetic. Skin incisions are closed with subcuticular 4.0 vicryl suture followed by application of steri-strips and a sterile dressing. Patients receive three peri-operative doses of a second generation cephalosporin and are given a clear liquid diet as tolerated six hours following their operation for uncomplicated appendicitis and usually one to two days for ruptured and gangrenous appendicitis.

RESULTS

Between December 1990 and February 1991, 25 patients (21 males, 4 female) between the ages of 18-45 (mean age 22) were offered the opportunity to undergo laparoscopic appendectomy. Twenty-three patients had the preoperative diagnosis of suspected appendicitis. One patient in our series presented with a one and a half year history of right lower quadrant abdominal pain and an intra-luminal appendiceal foreign body seen on ACBE whereas another underwent diagnostic laparoscopy for infertility and was noted to have an abnormal appearing appendix. Histopathology revealed the following: one normal, eight necrotic/gangrenous, seven suppurative, eight acutely inflamed, one endometrioma of the appendix, and one with focal lymphoid hyperplasia and mucosal necrosis consistent with the presence of a foreign body. The patient with a normal appendix was later found on stool culture to grow out campylobacter jejuni. Our patient population is similar to that of Gotz who had approximately 74% of patients with an acutely inflamed appendix in contrast to Schreibner who treated a relatively healthy population with only 25% of patients having an acutely inflamed appendix [3,4]. Semm, Leahy, and Gangal did not report results of histopathology.

We have encountered only one retrocecal appendix so far and it was not especially difficult to remove. Our first four patients were kept in the hospital for the standard period of time (three to four days) following a traditional appendectomy. Likewise, they were given the standard period of postoperative convalescence (two weeks of home leave followed by two to four weeks of limited duty). As we gained confidence in the procedure and observed the patient's rapid recovery, these times were subsequently reduced. Since then, the average length of hospitalization has been 1.5 days with return to work and a normal lifestyle within seven days of their operation. These results are consistent with those reported by Leahy and Gangal [5-6]. Semm, Schreibner and Gotz report hospitalization periods of one week with return to work soon thereafter [2-4].

Postoperative pain has been minimal. Most are pain free by POD #4-5. All previous studies report decreased postoperative pain but have not attempted to quantify it. All of our patients complete pain score sheets.

We have experienced two complications. One was a postoperative wound infection which occurred following closure of a dirty wound. Contamination occurred when a suppurative appendix was removed through one of the puncture sites prior to the use of an "appendix bag." The literature reports a very low

complication rate associated with laparoscopy and laparoscopic appendectomy [4,6-8]. Gotz in his series of 388 patients (74% of whom had acutely inflamed appendices) reported the following complications: uncontrolled bleeding (3/388), appendiceal stump blowout (1/388), intraabdominal abscess formation (3/388 patients with perforated appendices), omphalitis (14/388), and no wound infections. Schreibner in his series of 150 patients (24% of whom had sub-acutely or acutely inflamed appendices) reported a complication rate of 1.4% in his first 70 patients that dropped to a 0.85% by the conclusion of his study. His complications included: stump blowout (1/70), and UTI (2/70). Leahy in his series of four patients reported no complications [5]. Complications were not discussed in the papers by Semm and Gangal. In the gynecological literature complications agerage 1-2% (range between (0.6 - 3.6%) when performing surgical laparoscopy [7-8]. Major complications are reported to occur in 0.3 - 0.5% of cases. Death rate from the procedure ranges from 4-8/100,000 which includes anesthetic and surgical causes. The most frequent cause of death is cardiorespiratory arrest during general anesthesia. Major vessel damage from insertion of Veriss needle or sharp trocar (occurs at rate of 0.5 - 2%) [8-11]. Traumatic bowel injury is rare and is usually associated with previous surgery or cancer (1/11, 1/100, 9/12,182, 11/56,106) [7-8]. This complication has been overcome by switching from electric coagulation to use of Hulka clips for hemostasis since most bowel trauma is secondary to burns. Even switching from unipolar electrocoagulation to bipolar electrocoagulation or endocoagulation has resulted in minimization of this complication [8,10,11]. Cardiovascular collapse is rare, thought to be secondary to CO_2 embolism versus a severe atypical vagal reaction [12]. Urinary bladder injury, splenic laceration, and gastric perforation have also been reported [7-8].

We have used peri-operative antibiotics in all our cases in contrast to Gotz and Schreibner who rarely used them. Gotz used antibiotics only in cases of perforated appendicitis. Schreibner used them in approximately 10% of his cases. Semm, Gangal, and Leahy did not discuss use of antibiotics.

We applied Hulka clips in a stepwise fashion across the mesoappendix. Scissors were used to transect it as each clip was placed until reaching the appendiceal base. Leahy used a similar clip called the Filshie clip, applied solely to the appendiceal artery and used in combination with electrocautery for maintenance of hemostasis. In contrast, Schreibner and Gotz used thermocautery and electrocautery respectively prior to its transection with scissors. Semm used a needle with thread passed through the mesoappendix near the cecal appendiceal junction and

tied around it after extracorporeal knotting. The mesoappendix was then transected with scissors.

We doubly ligate the appendiceal stump without applying topical iodine or performing stump coagulation and invagination. The discussion on stump management has been controversial. Proponents of stump invagination claim prevention of bacterial contamination of the peritoneal cavity and a decrease in postoperative adhesions from rough serosal surfaces. Opponents feel that this step may place the intestinal wall at greater risk of injury as well as predisposing the patient to the formation of an abdominal wall abscess [4].

Semm recommends stump invagination as a standard procedure [3]. Neither Gotz, Schreibner, Gangal or Leahy uses this method of managing the appendiceal stump.

All three German surgeons (Semm, Schreibner, and Gotz) use endoloop ligatures for securing the base and electro or thermocoagulation to seal the appendiceal stump followed by topical iodine application as a disinfectant [2-4]. Leahy and Gangal simply use a Filshie clip and rubber band respectively [5,6]. Drawing from the experience of our gynecologists who have performed thousands of laparoscopic procedures without reporting any complications from not closing the fascia, we have only been closing our wounds in a single layer using subcuticular 4.0 vicryl suture followed by steri-strips. Leahy and Schreibner also only close the skin. Gangal closes skin and fascia, whereas Gotz closes all three layers using staples for the skin [3,6].

Extraction of a large appendix from the abdomen can be challenging. When an appendix could not be pulled out through either the appendix extractor or sheath, then we pulled it up through one of the trocar puncture sites much in the same manner that the gallbladder is delivered during a laparoscopic cholecystectomy. We have performed extraction of the appendix in this manner on three occasions. As suggested by our only wound infection, when the appendix is removed in this fashion, it appears necessary to leave the puncture site open, to close either by secondary intention. Closure usually occurs over a 5-7 day period. Since performing the first 11 laparoscopic appendectomies, we have developed a new method for sterile extraction of an unusually large appendix from the abdomen. It involves the use of a latex rubber sleeve which is used as an appendix extracting bag. Only Schreibner has discussed management of the large appendix, which he handles by inserting a trocar, sheath, and appendix extractor measuring 10-20 mm in diameter [4].

We routinely used 0.5% Marcaine injected into and around the puncture sites. This has dramatically reduced postoperative pain. Leahy has reported using Marcaine, whereas Semm, Gotz, Schreibner and Gangal have not [5].

Our median length of operating room time (initial skin incision to application of dressings), has been approximately 1 hr 15 min. Prior to performing laparoscopic appendectomies at Tripler Army Medical Center, the average length of time to perform an appendectomy was approximately 1 hr 5 min.

Gangal reports that his technique takes slightly longer than a standard appendectomy, whereas Leahy, Schreibner, and Gotz report operating times of 10 min, 15 min, and 15-20 min, respectively [3-6]. Reasons for our procedure taking substantially longer are multifactorial but mostly related to our position on the learning curve:

1. Lack of experience with technique
2. All procedures performed by resident surgeons in training
3. Constantly evolving procedure with frequent modifications being made as the technique is refined
4. General surgery scrub techs and/or personnel not yet fully acquainted with laparoscopic surgical equipment
5. Currently lacking new mini-instruments and high tech equipment such as the high flow insufflators, etc. and new mini instruments
6. Operating time measured from skin incision to dressing application rather than to skin closure.

Our experience with discriminating between a normal and an inflamed appendix has been excellent. We were able to make the distinction in 23/25 patients based strictly on laparoscopic examination. Current literature reports the diagnostic accuracy of laparoscopy to be approximately 80%.

Patient satisfaction has been high with improved cosmesis, decreased postoperative pain, decreased hospitalization and convalescence.

At our institution, where over 200 appendectomies are annually performed for acute appendicitis, we estimated that performing laparoscopic appendectomies could potentially result in substantial economic savings for the U.S. Army approaching $350,000 per year. This takes into account decreased length of hospitalization and convalescence with earlier return of our young soldiers to active duty.

CONCLUSION

Our early results have been extremely encouraging. Laparoscopic appendectomy appears to be a safe, cost effective, minimally invasive surgical technique that in skilled hands may be utilized to remove most diseased appendices. Its advantages over performing appendectomy through a laparotomy incision are many to include the following:

--decreased postoperative pain

--decreased hospitalization

--decreased convalescence

--economical

--cosmetically more acceptable

--it affords a better opportunity to evaluate other intra-abdominal organs at the time of appendectomy as well as to assess the extent of peri-appendiceal disease

--possibly decreased incidence of postoperative adhesions as described by Semm

Several other methods not described in the literaure can be used for transection of the appendix and its mesentery. The laser (KTP/YAG and CO_2) is being used by some, whereas others have been testing a laparoscopically induced GIA stapler that is currently in the development stage. We foresee, with the advent of a successfully developed laparoscopically induced GIA stapler in combination with the "Appendix Bag" or other aseptic method of appendiceal extraction, that the laparoscopic approach to removal of the appendix could potentially become the accepted and preferred method.

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