

How minimally invasive esophagectomy was implemented at the Norfolk and Norwich University Hospital

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The minimally invasive esophagectomy (MIE) fellowship

MIE is a highly complex major surgery, which requires a lot of discipline to learn, master and to teach. It is not surprising to hear about serious on-table disasters, and even mortality. I believe that the year that I spent learning MIE and all the other aspects of minimally invasive esophageal surgery in UPMC (Pittsburgh) under the auspices of Professor James D. Luketich was undoubtedly the most inspirational and enlightening surgical training I have experienced. This was the MIE fellowship everyone wanted. There was a huge volume of work, and the expectations and teaching were unparalleled. It prepared me very well! There is no doubt that if you want to train to the highest standard in any technique, you have to be prepared to sacrifice, work hard, and be determined to learn. This was made easier at UPMC because it was a high-volume esophageal cancer centre, with a very high quality of training and excellent standards of perioperative care. We had ample opportunity to train everyday (including Saturdays). Ultimately I assisted at or performed over 90 MIE, and the technique became second nature. It was a privilege to work in such an environment, and to learn from everyone there. I embraced the opportunity with open arms.

The beginning—make them believe and show them the way

Introducing a new procedure in the National Health Service (NHS) in England requires a formal application to the hospital's Clinical Effectiveness Committee (CEC). They are responsible for assessing, and approving the

procedure, and submitting summary reports of outcomes to the clinical governance committee, who then decide on the application at divisional board meetings. The National Institute for Health and Clinical Excellence (NICE) had published up-to-date guidance on MIE (1), which supported the use of this procedure provided that arrangements were in place for clinical governance, consent and audit with local review of results. The application to CEC included clinical evidence for the procedure, the applicable patient group, the evidence of benefits to patient/service, risk assessment, clinical training needs assessment, clinical audit plans and how patients would be informed about the new procedure. Prospective audits of detailed outcomes of the first 10, then 20, and finally the first 50 consecutive MIE cases were presented to the CEC, before final approval was given.

A published consensus on MIE by the Association of Upper Gastrointestinal Surgeons (AUGIS) of Great Britain and Ireland in 2008 also provided guidance (2). It stated that, "Surgeons undertaking MIE should be fully trained in laparoscopic surgery at the hiatus, confident in intracorporeal suturing and competent with stapling in the context of minimal access surgery." The MIE "learning curve" is long and thought to be 20 to 50 operations but will vary from surgeon to surgeon. In my opinion, the learning curve is more likely to be 100 cases; after 50 cases, you are still learning.

MIE should only be undertaken in recognized cancer centers by surgical teams confident in the performance of the open equivalent of the proposed minimal access approach. Patient suitability for MIE should be discussed in the specialist upper GI multidisciplinary team (MDT) meeting. Ideal patient characteristics for surgeons learning MIE include low BMI (less than 30) with small early tumors

of the mid and distal third of the esophagus. Proximal third tumors should be avoided during the learning curve to reduce risk of airway injuries and we have found it beneficial for consultant surgeons to operate in pairs in order to provide each other with advice and support. Surgeons should have an honest and full discussion with their patients to obtain a full informed consent for MIE. This should include information on the pros and cons of MIE, the alternatives (open surgery), the experience of the surgical team, any problems previously encountered (i.e., audit data) and any mentoring arrangements. The surgeons should be confident that the oncologic standard of MIE procedure is equivalent to its open procedure at that centre. Prospective audit of the rates of resection margin positivity and lymph nodes yield is important.

During the early stages of a team's experience, it is recommended that they perform a lap assisted or thoracoscopic assisted esophagectomy (hybrid MIE), rather than a full MIE. This allows a stepwise introduction of the various elements of this complex operation and increases patient-safety within the whole team. The risk of thermal injury to the airway or aorta by diathermy or harmonic scalpel is higher during thoracoscopy than in open surgery and surgeons should exercise extreme caution when operating close to the aorta, aortic arch, trachea and bronchi. Conversion to open surgery should not be considered a failure, and if in doubt, surgeons should revert to this approach.

In Norwich, I was fortunate to have the support of excellent thoracic surgeons, the critical care unit, gastroenterologists, oncologists, and radiologists, on whom I was able to rely for good discussion and sound second opinions. The key to a successful operation was not to be too hasty or careless in key steps of the MIE. There are certain steps in MIE, which can be performed faster, as experience is gained, and some steps that require more precision and meticulous dissection, especially near the airways and the formation of the anastomosis.

Our case selection was exactly the same as for open Ivor Lewis esophagectomy. Patients with resectable cancer of the mid/distal esophagus or oesophagogastric junction (OGJ) (Siewert 1 or 2) were considered. Most MIE were performed after neoadjuvant therapy. It was important that patients being considered for MIE should to be deemed fit enough for open surgery as well. The MIE included two-field lymph nodes dissection (abdominal and thoracic lymph nodes). MIE aims to achieve the same result as open esophagectomy but with less postoperative morbidity and

hospital stay. Initially, we would only consider MIE for patients with a BMI less than 35.

During the consent process, patients were made aware of my MIE training in Pittsburgh under James D. Luketich, and that MIE was a new procedure in the hospital. Most importantly, it was explained that if MIE could not be safely performed because of one reason or another (e.g., dense adhesions), then we would proceed to an open approach. This approach was in the name of patient safety.

As the experience and confidence of the team grew, we would perform an MIE even in those up to a BMI of 50 provided adequate support (two consultant surgeons) was available. Finally, the prospectively audited data were also submitted to the National Oesophago-Gastric Cancer Audit (NOGCA) in England.

Despite the meticulous set up and hard work, there were still doubters and obstructers. One is easier to deal with than the other. However, it was the independent reviews from NOGCA and Dr. Foster's, which ranked our outcomes as one of the best esophageal unit in UK, that gave us recognition and more believe that we were doing the right thing for our patients.

Anesthetist

An initial audit at Norfolk and Norwich University Hospital showed that there were 15 anesthesiologists involved in esophagectomy each year, with some doing less than five cases a year. Through discussion and agreement, we reduced their number to 5, which provided more experience, consistency and continuity for the anesthetist within the team. A general problem in UK (perhaps in Europe too) was that some in the Anesthesiology department were not enthusiastic about MIE. Previous bad experiences with other laparoscopic surgical procedures plus lack of experience in MIE, led to preconceptions that this was not a good operation for the patient.

Our lead anesthetist was experienced in open esophagectomy only. He read all he could, and we travelled to UPMC, Pittsburgh for a MIE course to learn more from other anesthetists and to meet my mentors and friends. The take home messages were to use more fluid intraoperatively, avoid epidurals and minimize vasoconstrictors in order to maximize perfusion of the gastric conduit. We were happy to use more intravenous fluid to maintain the blood pressure instead because this was not lung surgery. We avoided the use of ketamine but introduced spinal blocks with morphine, intercostal nerve blocks and paravertebral/

subpleural catheter along with patient-controlled analgesia (PCA) for postoperative pain control (having a PCA also meant that the MIE patient required more frequent and regular monitoring by nurses). The objective was to get the patient mobilizing independently as quickly as possible, with as few lines, drains and tubes as possible. Independently, the anesthetist also carried out his own prospective audit and his results also confirmed that MIE provided enormous benefits to our patients. It was very useful for the team to have consistency—the same surgeon and anesthetist. I performed the first 50 consecutive MIE cases with the same anesthetist, to provide continuity and a consistent team working and learning together.

MIE—don't reinvent the wheel

It is important not to reinvent the wheel. The first ten MIE cases in Norwich were performed as I was trained to do in Pittsburgh. Cases were performed with another consultant surgeon who had no MIE experience but keen to learn. Patient selection was decided at a MDT meeting for esophageal cancer. Initially we selected patients with BMI less than 35, and with smaller distal esophageal tumors. As confidence grew, we accepted all types of patients and small modifications were introduced. These included more radical lymph nodes dissection in the abdomen and chest (where patient body habitus and anatomy allowed).

A YouTube video on MIE by Nguyen NT (who was trained by James D. Luketich), advocated opening the 5 cm access site in the thorax at the beginning of the thoracic phase. This added further access and vision from the beginning, especially when applying the diaphragmatic retraction stitch and saved time. An intercostal nerve block was added prior to opening the 5 cm access site and muscle incision into the latissimus dorsi was minimized to 2 cm before performing a muscle splitting procedure with two Langenbecks to stretch it to 5 cm.

Working with the OR team

The OR team were excited about the MIE and keen to learn. The team leader team was extremely supportive and engaged. Initially, we did not have all the instruments needed, and had to beg and borrow from the thoracic and gynecology team. In the meantime some improvisation was necessary. It took almost 2 years before we were given permission to purchase the Endo Stitch (®Medtronic), for the formation of the purse string sutures on the proximal

esophagus in preparation for the anastomosis. Prior to that it was done intracorporeally with a laparoscopic needle holder (it took a lot longer to execute). Educational lessons on MIE with lots of pictures in PowerPoint presentations were provided and organized events outside the hospital helped with team-building. Debriefing after the MIE allowed us to talk about issues we encountered (e.g., what went well, and how could we improve) and gain more insight into what we were trying to achieve.

Training the surgeons

Training surgeons in MIE can be a very enjoyable or it can be difficult, depending on their competency in advance laparoscopic skills. MIE is at the highest level of difficulty and complexity for a minimally invasive procedure. In Norwich, MIE is a two consultants operation and the training starts in the abdomen (not the chest because in UK, they are gastrointestinal surgeons who are more confident in the abdomen, and it also allows them time to get use to the stapling devices, intracorporeal suturing, and tissue handling). The second surgeon is not just a camera holder, but also a retractor and is the person that drives and leads the operation. You can assess a lot of the surgeon's laparoscopic skills and tissue handling in the abdomen phase of MIE. MIE is a strict discipline and shortcuts must be avoided. An intimate knowledge of anatomy is paramount, especially in the thoracic phase. Some patients can be more challenging and you have to improvise with the additional of 5 mm ports. Some surgeons are good at understanding, remembering and following instructions. Some may not have the insight about their competency and are still learning laparoscopic surgery, tissue handling, intracorporeal suturing and the use of stapling devices. Some surgeons pick up laparoscopic techniques faster than others while some struggle to remember even the ports positions, which is a useful sign that it is going to take a little longer to teach. If the ports are inadequately positioned, "you can make an easy operation difficult, and a difficult operation impossible (Luketich)." Formation of the intrathoracic esophago-gastric anastomosis is the most difficult part of the operation—it needs good concentration, a lot of skill in tissue handling and suturing, and the correct usage of the circular stapler. We take a good 10 min rest before formation of the anastomosis, when we scrub and leave the room for refreshments, before completing the anastomosis. Remember, the hybrid MIE (laparoscopic then right thoracotomy) is a good stepping-stone towards a

total MIE. Many surgeons who are presently learning MIE would benefit from this bridging step.

Our unit is consultant led, and the surgeons are proficient in upper GI endoscopic skills too. To be able to examine the anastomosis and the gastric conduit rapidly when the patient is unwell, perform an endoscopic balloon pyloroplasty or insert a nasojejunal feeding tube is very advantageous. In addition, knowing how to perform a flexible bronchoscopy and bronchial toilet is advantageous too.

Reports of on-table mishaps during MIE speak volumes about the difficult learning curve, the poor training currently available, as well as a possible lack of insight. My advice would be to visit other MIE units, have a proctorship/mentorship programme in place, or even better an MIE fellowship. MIE has a very long learning curve. Take it in steps, and move from a hybrid MIE before leaping into a total MIE.

Prehabilitation—eat well, train well, do well

The evidence behind prehabilitation came from sports medicine and is now better appreciated in surgery (3). This is really a no brainer. At the initial clinic visit, before the patient starts neoadjuvant chemotherapy, the patients' fitness and nutritional status are assessed. With the help of the family and dietitian, we try to improve the nutritional status by eating better food (which may need to be liquidized), using nutritional supplements, and if needed, a nasogastric (NG) feeding tube (most dysphagia improves significantly after the first chemotherapy). I also personally walk patients up two flights of stairs (two floors), to assess their cardiopulmonary fitness and their determination. The aim is to do it in less than one minute. At the end of the stairs test, if they are still able to speak in complete sentences, and are not severely short of breath, they are deemed fit and have sufficient cardio-respiratory reserve for MIE. They are also encouraged to continue to get fitter. We discuss the possibility of exercising on an exercise bike (cost from £40) for 30 min twice a day (the key is they have to be sweating or out of breath by the time they finished each session). Alternatively, patients could join a local gym for a subsidized fee. In addition, smoking cessation is vital to reduce the risk of anastomotic leak (nicotine is a vasoconstrictor) and chest infections. They are lead to believe that if they eat well and train well, they tend to do well. They are encouraged to believe in the process and we engage the help from their family members. It is even more important that medically complicated patients are

well prepared. Most of our patients would have received neoadjuvant chemotherapy or chemoradiation therapy before MIE; our practice is to delay the operation till 6 or 10 weeks after the respective neoadjuvant therapy to allow them to recover and prepare properly for surgery. An up-to-date staging CT scan is obtained, and a cardiopulmonary exercise (CPEX) test prior to a review in a preassessment clinic by an anesthetist. I see the patient early on after completion of the neoadjuvant therapy, to ensure that they are eating and exercising well.

Less is more (and keep it simple)

In any system or institution that is financially constrained and constantly understaffed, it is important to find a very efficient and effective way of carrying out healthcare safely without compromising the outcome. One is expected to do more for less, and sacrifice something. Leadership and organization is therefore important, and the identification and prioritization of goals are vital. For example, the most important and difficult part of the MIE operation is the formation of the anastomosis. More time should therefore be spent on getting this perfectly executed every time. If this works perfectly, everything else is expected to fall into place. Performing a pyloroplasty and feeding jejunostomy in all MIE patients is unnecessary, in our experience. Very few patients have had delayed conduit emptying from a 4 cm narrow gastric conduit. If they do, an endoscopic balloon dilation of the pylorus with an 18 or 20 mm TTS CRE balloon usually treated the problem effectively.

If nutritional supplements were needed before the MIE (e.g., obstructed esophageal cancer post chemotherapy and dependent on NG feeding), feeding jejunostomy insertion one week before the MIE procedure can be performed at the same time as the staging laparoscopy. This allows the jejunostomy site to heal properly before it is used, and also saves time. It will be a bigger disaster if the jejunostomy leaks after the MIE. I do not routinely insert a feeding jejunostomy. If a patient develops an anastomotic leak post MIE, a nasojejunal feeding tube can be inserted endoscopically.

Early feeding, walking and talking

Enhanced recovery programmes have shown that early feeding of patient after any major surgery is associated with a much better outcome (4). This also applies to MIE. Patients are encouraged to help themselves on the ward

to nutritional drinks after the operation (by teaching and empowering the patient). An alternative to water is Fresubin jucy (not milk base), which they slowly sip (30 to 60 mL per hour initially, increasing with each post-operative day).

In addition, it is important to facilitate physical exercises after MIE. This is achieved through good pain control and drains which are easy to carry around, and hence facilitating independent mobilization. Our patient receives a spinal morphine, intercostal nerve block and a paravertebral catheter is inserted at the end of the MIE operation. PCA is also used on the ward. We use the Jackson-Pratt (JP) drain, which is easy to carry around and easy to teach the patient how to look after it. Initially, the use of a drip-stand (where the bags of IV fluid, PCA and paravertebral catheter pumps are attached) with good wheels is helpful for the patient to gain mobility and confidence. Our experience demonstrated that a good walk around the ward is better than any chest physiotherapy. On day 1 or 2, they are accompanied on their walk by a senior surgeon or a physiotherapist, and are reassured about the operation and their progress. Subsequently, they are urged to do their exercise independently (or with a family member), and to report if the analgesia received was sufficient. These are included in our standardized clinical care pathway for MIE.

Dealing with complications

Dealing with postoperative complications is difficult even in the best of times. The mental stress that the primary surgeon goes through in the management of a complication is poorly recognized (5,6) and not often discussed or spoken about. Having a second person to discuss with and to look at a problem helps clarify the situation enormously, and this is very reassuring. It provides clarity of thought! Having two consultant surgeons operating together and assisting each other, when taking a sick patient back to the operating room is extremely helpful. It is intuitively a very good way of dealing with major complications, especially after an MIE, for both the patient and the surgeon. The second surgeon is emotionally detached from the patient and provides a very objective eye on the whole situation, as well as reassurance to the surgeon involved. We believe this gives the patient the best possible chance for a good recovery.

Failure to rescue is well recognized in surgery (7). In our experience, most problems occur within the first three days after MIE. There are usually early signs of a problem when you look carefully, e.g., tachycardia, severe pain, and atrial fibrillation (AF) (these three markers are very

objective indicators that something is not right). Early recognition of a complication allows earlier treatment and a better outcome. This is essential for maintaining a very low mortality. Achieving a low mortality (less than 1%) after esophagectomy is not impossible. Experience from Hong Kong University Hospital (S. Law presentation in 2008 UPMC) from the 1960s through to 2006 show that a mortality rate less than 1% from open esophagectomy and a 0% leak-related mortality is achievable! I believe it is possible to have a very low mortality (<1%) after MIE, even for high-risk patients.

When a complication occurs post MIE, we do not sit on it! Avoid the ostrich effect. Our approach is to deal with the problem immediately and effectively. Common things are common. We discuss the problem between two consultant surgeons, and the aim is to rule out the big things such as an anastomotic leak or an ischaemic conduit. All the other complications are easier to treat. Our practice is to get a CT then OGD as initial investigations, and start the antibiotics and antifungal regime.

We perform an upper GI endoscopy post MIE when the CRP or WCC rises unexpectedly. Visualisation of the anastomosis will identify a leak or confirm its integrity, in which case the patient can be fed earlier. Obviously, proficiency in upper GI endoscopy is essential to recognize and treat the problem (it is a shame that some esophageal surgeons cannot or are not allowed to perform upper GI endoscopy in their OG units—they have to ask or beg another specialty to investigate or treat their sick patient promptly, hence putting the welfare of their patient into the hands of another doctor who did not do the surgery, and has less understanding of it). In addition, a nasojejunal feeding tube can be inserted at the same time, if a small leak is identified.

We don't believe in using stents for anastomotic leak. Instead, we prefer to deal with it in the operating room by means of an operation such as a video-assisted thoracoscopic surgery (VATS) washout and a suture if the leak is found within the first 3 days, otherwise we use a Kehr T-tube and JP drains. If the view is poor with VATS, and the angle of approach is inadequate to suture or deal with the problem, then a right thoracotomy is performed; this is often for anastomotic leak, which occurs on the left side or anteriorly near the airway. The approach to the problem can often be decided by performing an on-table endoscopy. Most of our anastomotic leaks are picked up and dealt with within the first three days post MIE. This gives us the opportunity for primary closure by means of a few interrupted full thickness

monofilament sutures (3/0 PDS) and putting a drain just below the leak. We never put the drain on the anastomosis as direct suction on the anastomosis will make it leak. Applying an omental flap on the repaired site helps too. We ensure the drain is within the omental flap but a centimetre below the anastomosis. We would also insert a nasojejunal feeding tube endoscopically to provide postoperative nutrition.

We try our best to get the patient home as fast and safely as possible, and put the care back in the hands of the patient and their family as most patients sleep and recover better at home. We let them resume responsibility for their health and interests, by empowering them with adequate information.

In our unit, we work in a pull system whereby our patients are referred directly back to us should something happen postoperatively, after they were discharged (some live at least 2 h away and may get referred back to their local district general hospital). In addition the patient and the family know to contact us if there is a problem. The pull system has the advantage of being patient-centered and therefore the patient will receive the right service for the right reason at the right time.

MIE for high risk patients

MIE is beneficial in this group of patients if they are fit enough for a general anesthesia and esophagectomy. These are not training cases and should not be performed by those on the learning curve. However, it is important to prepare the patient well. Encouraging the patient to prepare (prehabilitation) for their MIE plays a major role (see above). The patient gets a CPEX test and an echocardiogram before the MIE. Good communication with the anesthetist, critical care unit and the theater teams is vital before the MIE. It is important for the anesthetist to see these patients weeks before the operation. These patients do not tolerate complications well (so no school boy errors are allowed) and the margins for error are very narrow. We tend to operate with two consultant surgeons in these cases. Meticulous surgical technique and good tissue handling are therefore vital. There will always be some doctors who are afraid to take on these patients because they are afraid of what could go wrong, yet they forget about what could go right. Our strength is the strong believe in the team and what it can do, and has done. Post MIE, if there is any sign that the patient is not progressing (e.g., severe pain, sepsis, difficulty with breathing, unexplained tachycardia, or AF), prompt and early management should be instituted. Generally, we prefer to adopt a look and see rather than a wait and see attitude (early

CT scan and endoscopy), and back to the operating room when it is needed.

Be a giraffe

When you are a giraffe and you are receiving criticism from turtles, remember that they are reporting the view from the level they are on (Jakes). When I started MIE in Norwich I had many criticisms. “This is not America” or “we can’t do this” or “if you have no problem, we will have no problem.” Gradually, as time has progressed we have been able to raise the turtles up and provide them with the same view as the giraffes. The success of MIE in Norwich has been due to a huge team effort, and with constant education and repetition for the team, and finally making them a believer. There is no magic formula, just a lot of hard work and attention to every detail. Introducing the two-consultant surgeon for the MIE operation was a no brainer—it provides support for the surgeon, and allows the team to develop. At the beginning, I had the privilege to work with two senior surgeons (one a thoracic surgeon, and the other an upper GI surgeon) who inspired me to excel, and believed in me; when difficult circumstances developed, we overcame them together, as a team. Hence, our mortality post MIE is 0.7% (1 in 150 cases) and the median length of stay is 7 days. The success of the esophageal cancer unit is also a tribute to the team in the critical care unit, radiologists, gastroenterologists, anesthetists, physiotherapists, dietitians, pharmacists, oncologists, operating room staffs, pathologists and ward staffs. We do have an outstanding multidisciplinary team. Together, we worked through problems. The secret here is that the surgeons are always visible on the unit, always available and approachable to resolve a situation.

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Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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