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CASE NOTE REVIEW BOOKLET

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CASE STUDY 1: DEATH FROM TOXIC GASTRIC DILATION?

Case Summary

This patient underwent an uneventful resection of two colorectal metastases. The patient's initial care was in the intensive care unit (ICU), and the patient had three days of postoperative recovery in the ICU before being transferred to the ward. Following the procedure a nasogastric tube (NGT) was not used and fluids were permitted from the outset.

The responsible surgeon stated that the patient was reviewed by a colleague on the morning of the fourth postoperative day and considered well. The nursing notes from that morning record a low urine output and a soft but distended abdomen. The patient had not passed flatus and had low oxygen saturations. In the early evening the patient was found by the bedside with evidence of a coffee ground vomit. A medical emergency team (MET) was initiated. The notes recorded a distended abdomen as well as fixed, dilated pupils and asyctole.

The impression was that the patient had experienced a systolic arrest, and following resuscitation the patient was transferred back to the ICU. A laparotomy was performed in the ICU by the surgeon, and the only significant finding was a large, dilated stomach. The surgeon indicated that 2 L of fluid was aspirated while the intensivist noted that over 3.6 L of fluid was sucked up via the NGT. The patient was transferred to theatre to complete the laparotomy but no significant abnormality was found and there was no evidence of surgical misadventure. Overnight the patient developed multiple organ failure and died the following day.

Comment

It seems likely that this patient had a toxic gastric dilation, which can lead to death in two ways. The first is that the patient died secondary to vomiting and subsequent aspiration, although it would be unusual for an aspiration to be so massive and collapse so sudden. The second, and more likely explanation, is that death occurred as a direct result of the toxic gastric dilation.

Historically, toxic dilation is a well-recognised post-operative complication – in 1952 it was the subject of a Hunterian Lecture delivered in London by Sydney surgeon KW Starr. The pathophysiology has been well studied - as the stomach dilates there is substantial vagal stimulation. This stimulation reaches the point that the heart becomes not only bradycardic, but asystolic, most likely secondary to complete arteriovenous (AV) block. Asystolic arrests are difficult to resuscitate, as the underlying vagal stimulation remains present until the stomach is decompressed. As this may not be appreciated by the treating team, patients who arrest as a result of toxic gastric dilation have a high mortality rate.

Systemic changes in the previously routine use of an NGT following major abdominal surgery may also have played a role. The use of an NGT following major abdominal surgery has reduced since the advent of enhanced recovery after surgery (ERAS) pathways, although approximately twenty per cent of ERAS patients subsequently require an NGT. Inserting or reinserting an NGT is quick, and for a patient with suspected toxic gastric dilation it gives an instant diagnosis and immediate improvement in status. It also removes the vagal drive, which if left untreated, will lead to an asystolic arrest while simultaneously impeding successful resuscitation.

With the significant benefit of hindsight it may well be argued that there were warning signs of toxic gastric dilation, and the insertion of an NGT earlier on the fourth postoperative day

would have decompressed the stomach. The patient was not as well during the fourth day as on previous days, and the notes clearly record the abdomen being distended, the oxygen saturations being low and minimal bowel sounds with no flatus. The low urine output was presumably secondary to 3.6 L of fluid being sequestered in the stomach. However, diagnosis of toxic gastric dilation would have required a high index of suspicion as there was, as in most cases, no definite clinical feature to prompt the diagnosis.

CASE STUDY 2: A SERIES OF SYSTEMIC FAILURES LEADS TO DEATH FROM ABDOMINAL SEPSIS

Case Summary

An elderly patient with a one week history of abdominal pain presented to a regional hospital and was admitted overnight. A computed tomography (CT) scan performed the following day showed acute diverticulitis. The patient's C-reactive protein (CRP) was 97 nmol/L and white blood cell count (WBC) $13.7 \times 10^9/L$. The patient self-discharged the next day. It is assumed that the patient was given antibiotics to take home however this was not clearly recorded.

The patient re-presented at the emergency department (ED) in the late evening three days later with an acute abdomen. The WBC was $2.3 \times 10^9/L$ and CRP 282 nmol/L. The ED doctor recorded that the patient had 'worsening to generalised peritonitis' and the patient was admitted overnight. Blood tests performed in the morning showed a CRP of 334 nmol/L and WBC of $2.3 \times 10^9/L$. A repeat CT scan in the early afternoon showed perforated diverticular disease. The patient was transferred to a tertiary hospital by mid-afternoon and assessed by ED staff within 30 minutes, but was not seen by the surgical team until very late in the evening. The patient had faeculent peritonitis secondary to perforated sigmoid colonic diverticular disease. Surgery commenced shortly after the surgical team assessment, with a Hartmann's procedure performed by a non-consultant Royal Australasian College of Surgeons (RACS) Fellow.

The patient was hypotensive and acidotic (pH 7.25) shortly before dawn while in recovery. The patient was admitted to a general ward, however in the early afternoon was admitted to the ICU with severe acidosis. The patient responded well to supportive therapy and did not require ventilation. On the morning of the second day, approximately 30 hours after surgery, a MET call was placed from the ICU due to the patient showing reduced consciousness. The patient was reviewed 90 minutes later by the on-call consultant surgeon. A CT scan of the head was undertaken and the stoma was noted to be retracted and dusky. Later that day the patient was intubated. Over the next eight days the patient was seen by a succession of surgical doctors, apparently from the on-call team. While the names of the on-call doctors who saw the patient were documented there was no record of a consultant being present.

The patient underwent a second laparotomy in the late evening, eight days after the first laparotomy. This laparotomy was performed by a different surgeon to the first procedure, and the surgeon was neither a consultant nor a RACS Fellow. The retracted stoma was leaking faeces and there was extensive faecal contamination. The colostomy was refashioned and the abdomen washed out. The patient was returned to the ICU but died from sepsis four days later.

Comment

It is difficult to conclude anything other than that this patient's care was substandard. While it might be argued that an elderly patient presenting with faecal peritonitis would be lucky to survive, the fact that the patient lived so long suggests that with better care this patient may not have died.

A combination of events meant that there was a preventable delay of 24 hours in getting an elderly patient with a perforated colon into theatre. The mortality of patients with uncontrolled sepsis increases at seven per cent per hour of delay. The doctor at the

peripheral hospital failed to recognise that the patient had worsening sepsis. This meant that the patient did not receive an urgent transfer to the tertiary hospital, and there was also a delay in obtaining a CT scan. On arrival at the tertiary hospital there was an additional six hour delay before the patient had a surgical review.

Within the teaching hospital the core failure was a lack of direct consultant responsibility. It appears that the patient was under the care of the emergency team, and was managed by the emergency surgeons, rather than the nominated consultant surgeon. This meant that an acutely sick patient in the ICU was not seen by a consultant for eight days. It should be noted that the problems relating to patient care were associated with communication and team issues, rather than a lack of care by the consultant.

The lack of direct consultant responsibility is present from the outset. The consultant surgeon in charge of the case was not called into theatre during the first laparotomy, and this represents a serious communication breakdown. While it is expected that an on-call general surgeon can perform a Hartmann's resection, concerns were raised as to whether this particular general surgeon was competent to undertake the procedure. If the general surgeon was not able to perform the procedure a robust alternative arrangement should have been in place.

Patients undergoing a laparotomy for three-day-old faecal peritonitis very often require a second laparotomy after 48 hours. There was overwhelming evidence that the patient was still septic in the days after the Hartmann's resection. Despite this, the patient was not seen by a consultant for eight days. The only recorded evidence of a consultant surgeon reviewing this patient was shortly after the patient's admission to the ICU. The responsible consultant recognised that there was a 'delay of days in realising this patient needed a re-look laparotomy'. On finally being returned to theatre the patient was found to have predictably extensive faecal contamination. The retracted colostomy appears to have been a major issue and testifies to the quality of the initial surgery.

Following the first procedure the patient's initial postoperative care was not in the ICU. The documentation indicates that this was due to a lack of resources. That the patient did not receive initial postoperative care in the ICU is of concern, as an elderly patient with faecal peritonitis is likely to have greater need of ICU support than most other patients.

The peripheral hospital needs to review the supervision of its ED staff, as the patient was clearly septic at re-presentation. Based on the summary of issues outline above, it also is recommended that both the peripheral and teaching hospital review their organisational processes as a matter of urgency.

CASE STUDY 3: DVT PROPHYLAXIS MAY NOT HAVE BEEN ADEQUATE

Case Summary

A very elderly patient who was living alone and medically well, presented with a closed fracture of the left patella and right zygoma, and a forehead laceration, following a 4 m fall. Initially taken to a regional hospital for assessment and management, the patient was transferred to a metropolitan teaching hospital on the same day. The patient was assessed at the teaching hospital shortly after dawn on the following day and underwent expedited surgery six hours later. A modified tension band technique was used for internal fixation of the patella fracture.

The postoperative recovery was uncomplicated and the patient transferred to another metropolitan hospital for rehabilitation two days later. Heparin 5000 units, b.d. was commenced in the evening of the day the patient was transferred for rehabilitation. The patient was to be immobilised in a hinged knee brace for six weeks, with the range of motion progressively increased. The patient was allowed to full weight bear despite the immobilisation of the knee, and it is reasonable to assume that the patient was not confined to bed while in the rehabilitation ward.

The patient made an uncomplicated recovery over the next two and a half weeks. However, on the day of discharge the patient underwent a sudden deterioration and resuscitation was unsuccessful. The coroner's post mortem revealed the cause of death to be underlying bilateral pulmonary emboli.

Comment

There are two issues to consider, the first relating to the timing of heparin administration and the second to the anticoagulant administered. This patient had multiple risk factors for thromboembolism, including significant trauma and the immobilisation of the knee in a brace with locked extension. The patient was also elderly, and the incidence of venous thromboembolism rises with each decade for patients over the age of 40.

The patient missed one to one-and-a-half days of chemoprophylaxis. In a trauma situation it would be reasonable to withhold heparin prior to surgery, and for a period of time after the procedure, to allow haemostasis to be achieved. However, heparin was not started until the patient reached the rehabilitation ward. There is no evidence of chemoprophylaxis being considered or an alternative measure used, with the exception of thromboembolism-deterrent stockings. Of great concern is that even in hindsight the consultant believed that the use of the stockings alone was adequate prophylaxis.

The second issue to consider is the use of unfractionated heparin rather than low molecular weight heparin (LMWH). While the evidence for using chemoprophylaxis is based on decreasing deep vein thrombosis (DVT) rates, not pulmonary embolus rates, there is substantial evidence that LMWH is more effective in preventing DVT in hip replacement and hip fracture patients. However, there is a lack of reliable data in relation to the use of LMWH for lower limb trauma or immobilisation. There is also no evidence that LMWH decreases the rate of either pulmonary embolism or fatal pulmonary embolism.

Not all thromboembolic disease is preventable and it is unlikely that starting prophylaxis one day earlier would have affected the outcome. One key area for reflection is whether the delay in starting chemoprophylaxis was a deliberate decision or an omission. Either way, steps should be taken to prevent similar errors occurring in the future. In a similar situation, in which the patient remained under the care of the treating surgeon, this outcome could be difficult to defend.

CASE STUDY 4: ALL FOR THIRTY CENTIMETRES

Case Summary

An elderly patient with significant comorbidities underwent surgery to reverse a stoma. Comorbidities included bronchiectasis, which had resulted in an exercise tolerance of less than 50 m and stable chronic renal failure. The surgeon initially refused to operate, finally agreeing to perform the procedure based on the patient's belief that the stoma was significantly compromising their quality of life.

The stoma was associated with an anterior resection and loop ileostomy performed three years earlier following neoadjuvant therapy for a low rectal cancer. The procedure was complicated by a leak from the anastomosis, which resulted from an ischaemic sigmoid. This was resected and a mucous fistula created.

During the operation to reverse the stoma the dense adhesions made an anastomosis impossible (the left ureter was damaged and repaired). A decision was made to resect the residual colon and create an end ileostomy. The prior loop was taken down and anastomosed, presumably for added absorptive length.

Six days postoperatively the patient became septic. The patient was returned to theatre under the care of a different surgeon and the small bowel anastomosis was found to have leaked. The abdomen was lavaged and packed and the bowel stapled off. A re-look laparotomy was performed the next day and a new end stoma was manufactured. The patient was transferred to the ICU ventilated. Anticoagulation was withheld as the platelets were $54 \times 10^9/L$. The signs of sepsis abated after 48 hours and it appeared that the patient was improving; however the patient suffered a massive intracerebral haemorrhage that was deemed unsurvivable.

Comment

This case calls into question the competing principals of 'first do no harm' and the patient's right to self-determination. The surgeon initially refused to perform the procedure on a frail patient, but was persuaded to do so by the patient's belief that the stoma was having an insupportable impact on their quality of life.

This situation is fortunately rare, and the decision whether to perform a procedure can only be made by the surgeon on a case-by-case basis. The patient was aware of the high risk of mortality, and had full family support. In this case it was not inappropriate for the surgeon to agree to perform the procedure.

However, the intraoperative decision to re-anastomose the loop ileostomy and create a new end ileostomy was poor. The residual colon was presumably resected because of concern for its blood supply, so an anastomosis was a risk, not least in a patient with renal failure.

The massive intracerebral haemorrhage was most likely due to the sepsis and chronic renal failure. While the surgery was high-risk, and this was understood and accepted by the patient, the decision to anastomose the small bowel resulted in a death that was preventable.

CASE STUDY 5: ONCE AGAIN, DELAY IN MANAGING ACUTE COLITIS LEADS TO DEATH

Case Summary

An elderly patient was admitted by a gastroenterologist due to ongoing rectal bleeding and a history of known ulcerative colitis. Other than atrial fibrillation (AF) and hypertension, the patient was well and taking mesalazine (Salofalk) enemas. Initial patient management comprised intravenous (IV) fluids and hydrocortisone, but upon review diet was recommenced. A flexible sigmoidoscopy was performed five days after admission, revealing severe ulceration with fresh bleeding from above the limit of the exam. After two weeks of ongoing bleeding, and diarrhoea (up to 10 times per day) requiring several transfusions, the albumin had dropped from 27 to 17 and total parenteral nutrition was commenced. A repeat flexible sigmoidoscopy showed no resolution of the ulceration and bleeding and the decision was made to transfer the patient to a teaching hospital for treatment with infliximab.

Treatment with infliximab commenced, and while the diarrhoea settled the bleeding continued. A note states that the patient was discussed with the colorectal team, however there is no evidence that this discussion actually occurred. That afternoon there was a MET call for hypotension. The following morning a surgical intern interviewed the patient, and while the colorectal team were informed of the consult they were not directly involved. The following day the patient deteriorated and was transferred to the ICU. Cultures confirmed *Staphylococcus aureus* bacteraemia, which responded to antibiotics, and after two days the patient was discharged to the ward. Another referral was made to the colorectal team on the following day, however the patient had a further hypotensive episode. This was reviewed by the on-call surgeon who arranged for the patient to be transferred back to the ICU.

While there is no documentation from the colorectal team, a note from the ICU indicates that a non-operative approach was favoured despite the ongoing bleeding. Thirty days had elapsed since the patient was admitted, and during this time the patient had received some 39 units of packed cells in addition to considerable fresh frozen plasma and platelets.

The following day the patient was reviewed by a second member of the colorectal team. It was determined that the patient required urgent surgery due to the ongoing bleeding, and a proctocolectomy was performed. The operation progressed satisfactorily although there was intraoperative hypotension. The patient remained septic and hypotensive and the decision was made to return the patient to theatre the following day. Venous ooze in the pelvis was noted and the packs were left in place. The patient rallied postoperatively and inotropes were stopped. The patient was returned to theatre for pack removal and remained ventilated for 24 hours postoperatively.

Two days later the patient began to experience difficulty breathing from a combination of pneumonia and cardiac failure. The patient preferred continuous positive airway pressure (CPAP) to intubation, and was transferred to the ward after a further two days. This transfer back to the ward occurred 10 days after the initial laparotomy. Over the next five days the patient gradually deteriorated. Following discussion with the family it was decided that there would be no further increase in care, and death occurred 49 days after the initial presentation.

Comment

This patient's care was suboptimal in a number of areas that can be broadly defined as leadership, collaboration and communication. This case should have prompted the hospital involved to conduct a review of how colitis is managed. The patient seems to have drifted from one predictable complication to the next, with no individual or team taking overall responsibility. There appears to have been a complete lack of consultant leadership.

The hospital does not appear to have a multidisciplinary team involved in the care of complex colitis. This patient's management was far more complex than the management required for many cancer patients, and the latter would routinely be discussed at multidisciplinary team meetings. A collaborative approach between surgeons, gastroenterologists and allied staff may have led to the recognition that surgery was required weeks earlier. The delays in obtaining a surgical opinion and colorectal surgical review appear to be serious errors in patient management.

The communication between the teams appears to have been quite poor. In particular, there was either a lack of follow-up by the colorectal service, or a lack of documentation if follow-up did occur. There is a period of 14 days between the request to review to the actual written documentation. The justification for the non-operative approach is hard to establish if there is no documentation.

CASE STUDY 6: MISSED FEMORAL HERNIA (I)

Case Summary

This patient lived in a high-care nursing home and suffered from AF, osteoporosis, back pain, impaired mobility and dementia. The patient was admitted to the ED of a metropolitan hospital with a five day history of progressive deterioration, decreased appetite, vomiting and abdominal pain. The patient had a distended abdomen and tenderness in the right ileac fossa.

The abdominal x-ray identified dilated small bowel loops with air fluid levels, and the x-ray report suggested a partial small bowel obstruction. There was no evidence of overt sepsis and the inflammatory markers were mildly elevated, with a CRP of 23 nmol/L and a WBC of $12.9 \times 10^9/L$.

The ED doctors believed that the patient was constipated and the initial plan was to treat using suppositories. If no result was obtained within half an hour an enema would be administered, and if that was unsuccessful a manual evacuation was proposed. The patient was admitted under a medical team with a suspected diagnosis of constipation. The medical team's resident medical officer (RMO) was of the impression that the patient had a partial bowel obstruction. IV hydration was instituted, laxatives were prescribed and a dietetic view requested.

On the morning after admission the consultant physician suggested insertion of an NGT if the patient continued to vomit. A gastrographin enema and enema were requested but not performed. A second abdominal x-ray showed persistent small bowel obstruction, but there was still some gas in the rectum. On the second day after admission the patient had a non-tender distended abdomen with normal bowel sounds. The patient refused an NGT. The decision was made to start clear fluids and repeat the abdominal x-ray. A surgical review was requested and the surgeon identified a tender incarcerated femoral hernia.

The anaesthetists felt that the patient was too high-risk for the procedure to be performed at the metropolitan hospital and so the patient was transferred to a teaching hospital. At laparotomy it was found that the patient had an infarcted small bowel with a localised perforation. This was resected. The patient's postoperative recovery was slow, however the patient was not a candidate for the ICU and was managed on the ward. Despite ongoing medical therapy the patient died on the fifth postoperative day.

Comment

The delay in diagnosing the incarcerated femoral hernia was a major contributor to this patient's death. Either the groin was examined and the hernia missed, or the groin was not examined. Information on the state of the groin was not recorded, and the resultant assumption is that a groin examination was not performed. This patient's presentation is common in EDs and failure to perform a groin examination, and identify the presence of the hernia, was a significant oversight.

CASE STUDY 7: MISSED FEMORAL HERNIA (II)

Case Summary:

A very elderly patient presented to a country hospital with abdominal pain for the second time in 24 hours. A CT scan showed that the patient had a small bowel obstruction secondary to an incarcerated femoral hernia. During surgery the small bowel was found to be gangrenous and was resected, using a double layer continuous technique, followed by a primary suture repair of the hernial orifice. On postoperative day two the patient was found to have a lobar pneumonia. On day three the patient remained unwell and was transferred a substantial distance to a teaching hospital. X-ray at the teaching hospital suggested ongoing ileus.

When the patient arrived at the teaching hospital there was no ICU bed. In anticipation that an intervention might be needed, a secondary transfer was undertaken to another nearby teaching hospital. At the second teaching hospital a CT scan showed the hernia had recurred. A repeat laparotomy was performed on day five, not by the consultant surgeon, and a microperforation at the anastomosis was noted. The anastomosis appeared strictured, so it was resected and re-anastomosed with staples. The patient recovered well and was ready to be transferred back to the initial hospital when, on day 15, the patient required a MET call for hypotension and melena. A CT scan showed continued obstruction in a recurrence of the groin hernia. A decision was made to palliate and treatment was withdrawn. The patient died on day 16.

Comment:

It was unfortunate that the hernia and bowel obstruction were not identified during the patient's initial presentation. The first surgery was appropriate. Many surgeons would elect for a primary suture repair of the hernia in the presence of infection. A continuous suture repair of the small bowel is a valid technique, although most surgeons would opt to perform a one layer interrupted suture anastomosis. A continuous anastomosis does risk narrowing the lumen and that may have played a part in the decision-making. The transfer of the patient to a hospital without an available ICU bed should not have occurred. This resulted in an unnecessary transfer and delays to patient care.

The choice of the second surgeon to re-sect the anastomosis was reasonable. However the decision to attempt another primary suture repair of the hernia was poor. Having had the first repair avulse, it was not surprising that the second did the same, and this eventually led to the patient's death. In addition, performing a primary repair on tissue planes that had been already sutured and dehisced would have been quite difficult. Mesh repair in the presence of infection is contraindicated, however biologic mesh can be placed into infected fields. The use of biologic mesh, while expensive, may have been lifesaving in this case.

The patient's outcome may also have been different had the consultant surgeon been present at the second operation. This was a high-risk case and the operating surgeon made the wrong choice with regards to repairing the hernia.

CASE STUDY 8: EARLY SIGNS OF SEPSIS MISSED

Case Summary

An elderly patient was admitted for an elective closure of a loop ileostomy and repair of a parastomal hernia. This admission took place almost one year after the patient had undergone a low anterior resection with limited hepatic flexure colectomy, and loop ileostomy, for a mid-rectal cancer and dysplastic hepatic flexure polyp. A gastrografin enema performed four months prior to the current admission showed no leak.

The operation was performed by two advanced surgical trainees and the consultant was present in theatre. The stoma was dissected from the abdominal wall, and a stapled anastomosis was completed and oversewn with 3/0 PDS suture. The surgery was uneventful and took approximately one hour, and the patient was stable while in the recovery room. The blood pressure (BP) was low overnight (90-100 mmHg systolic; pulse 60-80) and there were four episodes of per rectal bleed. The patient was reviewed by the night RMO who gave a 250 mL bolus of Gelofusine and increased the maintenance IV fluids. The haemoglobin was 113 g/L (from 136 g/L preoperatively).

The patient was reviewed the following morning by the advanced surgical trainees who noted that the patient had low BP and ordered a second 250 mL bolus of Gelofusine. The haemoglobin in the morning was 106 g/L. The BP responded transiently but subsequently settled at 90-100 systolic. The pulse rate steadily rose until it reached 100 beats per minute at midnight. Around that time the patient complained of severe abdominal pain and oxygen saturations dropped to 83%. The night RMO reviewed the patient with the registrar and the upper abdomen was noted to be tender and soft with voluntary guarding. Repeat haemoglobin was 119 g/L and WBC $3.09 \times 10^9/L$. A chest x-ray was felt to show atelectasis in the left lung base.

On the morning of the second postoperative day, the patient was again reviewed by the advanced surgical trainees. The patient appeared well and indicated that no further per rectal bleeds had occurred. There was no documentation of the abdominal findings. The BP was noted to be low at 89/52 mmHg and pulse rate 110 beats per minute. The patient was given a 250 mL bolus of Gelofusine. The antihypertensive had been withheld since surgery.

The patient deteriorated later on the morning of the second postoperative day, and a MET call made due to hypotension. After two 250 mL boluses of Gelofusine the patient's BP rose to 101/57 mmHg, but there was a persistent tachycardia. The MET team recorded that the abdomen was tender and guarded. It was noted that the chest x-ray performed earlier showed bi-basal atelectasis and pneumoperitoneum. The impression was of a pulmonary embolus or sepsis. IV Tazocin (piperacillin/tazobactam) was commenced and the patient catheterised. The initial plan was for the patient to have a CT scan of the abdomen and a CTPA (not done).

The haemoglobin was 112 g/L, WBC $3.12 \times 10^9/L$, and blood gases showed pH 7.30, pCO₂: 42 mmHg, pO₂ 53 mmHg, HCO₃: 20 mmHg, and base excess -6 nmol/L. At noon the BP dropped to 78 mmHg systolic, heart rate 129 beats per minute and the patient was transferred to the high dependency unit (HDU). There were no further medical entries; however the nursing documentation charted a return to theatre that afternoon. During the laparotomy a perforation was found at the old ileo-transverse anastomosis with a peri-anastomotic abscess. The recent loop ileostomy closure site was intact. The adhesions

were taken down and both anastomotic sites resected. The distal transverse colon was stapled closed and an ileostomy created. The patient went to the ICU ventilated.

The patient progressively deteriorated over the next two days. The stoma was pink and the abdominal drains were not purulent, and it was felt that re-operating would not help the patient's recovery. The patient passed away shortly after.

Comment

Closure of loop ileostomy is normally a simple and safe procedure, but it can be associated with significant morbidity (17%), leak (1.4%) and even mortality (0.4%). In this particular patient the leak was at an unusual site: the previous ileo-colic anastomosis. The leak resulted from the dissection at the time of ileostomy closure, as the most recent preoperative gastrograffin enema did not demonstrate any leak at either anastomotic site. The first operation was done by two advanced surgical trainees who should have been competent.

There were many, perhaps initially subtle, signs in the immediate postoperative period that suggested that something was wrong. The chest x-ray performed early in the morning of the second postoperative day showed a large pneumoperitoneum that the radiologist suspected was 'greater than to be expected' after surgery. This opinion from a very experienced radiologist may not have been appreciated by the junior doctors covering the night. Although not febrile, the postoperative leucopenia was indicative of severe sepsis. The abdomen was noted to be tender and guarded on two occasions. Documentation by the surgical team on both morning ward rounds was deficient in that there was no mention of abdominal examination findings.

By the time the MET team was activated it was obvious that something had seriously gone wrong, and a re-operation would be required. Documentation by the surgical team was again deficient. There is no record as to whether the consultant was informed or who made the decision for laparotomy. The second operation was done expeditiously by the consultant surgeon and the patient received excellent postoperative intensive care.

CASE STUDY 9: ANASTOMOTIC LEAK AFTER SURGERY FOR LARGE BOWEL OBSTRUCTION

Case Summary

An otherwise well elderly patient developed a large bowel obstruction. Due to external factors, despite being symptomatic for one week prior, there was a delay in the patient presenting to the hospital. At presentation, the patient was very thin and malnourished. An uncomplicated anterior resection for an obstructing distal sigmoid carcinoma was performed one day after presentation. An on-table emptying of the colon was undertaken and a primary stapled anastomosis performed with a loop ileostomy. The anastomosis was tested to be airtight.

Following the procedure the patient did well initially. However, at 48 hours postoperatively, the patient was found to have a tachycardia which persisted and increased over the next three days. The stoma output was reasonable. The patient remained afebrile and while blood tests, urine output remained in the acceptable range, the patient failed to progress over the next four-to-five days. The patient then became progressively more unwell and hyperkalaemic, with a decrease in urine output and a marked tachycardia. There was no specific point that an anastomotic leak was diagnosed.

The patient's condition started to deteriorate rapidly on day six. A laparotomy was performed and a gross dehiscence of the anastomosis with faecal peritonitis was found. This was washed out, the rectal stump closed and an end stoma performed in the left iliac fossa. The patient died in the ICU from overwhelming sepsis two days later.

Comment

The procedure appears to have been technically straightforward, although there was a note by the registrar stating that the marginal arterial flow was just adequate. It seems likely that the leak was secondary to ischaemia. The operation, an anterior resection with covering ileostomy, was appropriate.

Although previously in good health (American Society of Anaesthesiologists [ASA] grade 1) the patient failed to thrive postoperatively. There were subtle changes that may, perhaps should, have raised the suspicion of an anastomotic leak. In particular, the persistent tachycardia, that the patient was feeling unwell, and the gradually falling urine output on day three. The benefit of hindsight notwithstanding, it is likely that the diagnosis of a leak was delayed. The leak probably occurred on the second or third day, with faecal contamination present for at least 48 hours.

CASE STUDY 10: POSSIBLE COMPLICATION OF METHOTREXATE

Case Summary

An elderly patient underwent an elective open neck exploration and parathyroidectomy for primary hyperparathyroidism. There was a background of hypertension as well as rheumatoid arthritis that was being treated with prednisolone and regular methotrexate. It is not clear from the medical record whether the patient had any preoperative investigations, as they may have been done outside the hospital, but the patient did not attend a preanaesthetic clinic. The operation was uncomplicated and the patient was reviewed by the consultant surgeon the next day and discharged home well. The calcium and parathyroid hormone levels were checked, however there is no record of a full blood picture being undertaken.

The patient re-presented on the fifth postoperative day with a three day history of a painful, erythematous and swollen neck wound consistent with cellulitis. There was also significant mucositis and this was preventing good oral intake. Blood investigations showed significant abnormalities: acute renal impairment, neutropenia and raised inflammatory markers (CRP 243 nmol/L). The patient was admitted in order to treat the cellulitis with IV antibiotics. That night the patient developed AF and was admitted to the critical care unit. The next day the patient's WBC was $0.7 \times 10^9/L$, and a haematology review suggested that the WBC changes could have been due to sepsis, or were perhaps related to the use of methotrexate. The antimicrobial treatment was broadened to include fungal and viral infections, in addition to bacterial infections.

Four days after admission the patient was transferred to the care of the haematology team. The next few days were characterised by slow clinical improvement despite the ongoing issue of decreased oral intake due to mucositis. Results of the blood investigations were worsening with features of bone marrow suppression: the haemoglobin fell into the around the 70 g/L range, thrombocytopenia and a WBC less than $1 \times 10^9/L$. Filgrastim was prescribed to stimulate neutrophil production.

Approximately eight days after readmission the patient's conscious state deteriorated, with the Glasgow Coma Scale (GCS) score fluctuating around 8 and 9. A CT scan of the head and abdomen did not find a primary cause. Further blood tests suggested liver failure, with markedly abnormal liver functions, increasing renal impairment and encephalopathy. The most likely diagnosis was hepatorenal syndrome on a background of sepsis and immunosuppression, secondary to methotrexate and prednisolone. CRP levels continued to rise, reaching 361 nmol/L, and the conscious state deteriorated. Following discussion with family palliative care was commenced, and the patient died approximately six days later, two weeks after readmission.

Comment

This patient appears to have died as a result of wound infection and the resulting systemic sepsis. This was most likely exacerbated by immunosuppression secondary to the methotrexate and prednisolone used to treat the rheumatoid arthritis. There was a suggestion that methotrexate toxicity may have been present due to patient overdosing, however there was no precise evidence in the medical record to confirm this. The methotrexate level was 0.01mg at re-presentation, however it is not clear how this should be interpreted, as the timing of the patient's last dose is unknown.

This appears to be an unexpected and possibly rare complication. The patient died from systemic sepsis resulting from the wound infection, despite good efforts to treat the sepsis.

As preoperative blood tests were not made available for this review, the possibility of the neutropenia being present preoperatively could not be ruled out. Further investigation is needed in order to confirm that the treating team did not fail to identify the preoperative presence of neutropenia.

CASE STUDY 11: URINARY INFECTION DISTRACTS FROM LEAKING ANASTOMOSIS (I)

Case Summary

An elderly obese patient who was living independently underwent a colonoscopy for altered bowel habits and obstructive symptoms. The patient was found to have a stenosing cancer in the transverse colon and surgery was recommended to prevent complete bowel obstruction.

The patient was on warfarin for AF and a permanent pacemaker had been inserted ten years earlier for sick sinus syndrome. The patient suffered from panhypopituitarism, having previously had a pituitary tumour, and was on cortisone, desmopressin spray, testosterone and thyroxine. The patient was also taking valsartan for hypertension and Nexium (esomeprazole) for reflux symptoms.

The patient underwent an open right extended hemicolectomy. Through a midline incision a bulky tumour at the hepatic flexure was resected. The anastomosis was stapled and reinforced with 3.0 PDS sutures. No drain was inserted. Postoperatively the patient had regular IV hydrocortisone, heparin, flowtrons, patient-controlled analgesia and was in the ICU for monitoring. The patient was discharged from the ICU on the first postoperative day. Three days later the patient had a bilious vomit but recovered after insertion of an NGT. The next day the bowels opened with a large amount of diarrhoea.

On the eighth postoperative day the patient complained of abdominal pain. The abdomen was distended and tender on the right side. The patient was also hypotensive, thought to be secondary to the antihypertensive medication. The CRP level was raised and urinalysis showed blood +, leucocytes +, and protein ++. Urinary sepsis was considered possible.

On the ninth postoperative day the patient complained of shortness of breath and a stat dose of frusemide was given. A chest x-ray performed in the morning showed a pneumoperitoneum, but this was not noted when reviewed. A CT scan of the abdomen in the afternoon showed a large amount of free gas and fluid, suggesting the presence of an anastomotic leak. The patient was transferred to the ICU for optimisation prior to surgery and warfarin reversal. In the late afternoon the patient was returned to theatre and a leak at the ileocolic anastomosis was found. A loop ileostomy was formed and a number of drains were inserted. There was no gross faecal contamination.

The patient was nursed in the ICU. In the early evening the patient developed an arrhythmia and hypotension. This was followed by asystole and the patient died despite resuscitation being performed for one hour.

Comment

This patient was clearly high risk but a stenosing cancer meant that there was little alternative but surgery. The only change that may have prevented death would have been earlier recognition of the anastomotic leak. There was at least a 24 hour delay, as the patient complained of abdominal pain and was noted to be hypotensive the day before the discovery of the leak. The patient was steroid dependent and had a permanent pacemaker, so any tachycardia or signs of peritonitis would have been masked.

A leak should have been the primary diagnosis when this otherwise well patient became unstable. The urinalysis was a red herring. The patient's chest x-ray showed a pneumoperitoneum, so it is questionable as to whether the confirmatory CT scan was necessary.

CASE STUDY 12: URINARY INFECTION DISTRACTS FROM LEAKING ANASTOMOSIS (II)

Case Summary

An elderly patient of a low-care nursing home was admitted for an elective extended right hemicolectomy. The patient had presented about a month earlier with a five day history of per rectal bleed and collapse. A CT scan revealed a 10 cm circumferential thickening of the splenic flexure, highly suspicious for malignancy, and this was subsequently confirmed by a colonoscopy. The patient's medical history included multiple transient ischaemic attacks, AF, hypertension, mild dementia and previous alcohol abuse. Past surgical history included a cholecystectomy, appendicectomy and presentation with small bowel obstruction due to adhesions.

The patient was deemed fit for surgery following appropriate preoperative assessment. An extended right hemicolectomy was performed by a consultant surgeon assisted by a senior trainee and there were no intraoperative difficulties. The patient made satisfactory progress and was scheduled for discharge on the sixth postoperative day, although the physiotherapist wanted mobilisation prior to discharge. A decline in the level of consciousness was noted late on the morning of the sixth day. The patient's vital signs were stable but there was a low grade temperature and the initial impression was of a possible urinary tract infection. The following day the patient appeared confused and unwell, with generalised lower abdominal pain. There was tachycardia with an irregular rhythm and the raised inflammatory markers rose in one day. Tenderness in the flank area with mild erythema and poor urine output was noted by the trainee registrar in the afternoon. The diagnosis was bilateral pyelonephritis and antibiotics were commenced. There was a MET call about two and a half hours later.

The MET team documented hypotension, tachycardia and hypoxia. The abdomen was mottled and distended. Following resuscitation the patient was transferred to the ICU for ventilation and inotropic support. In view of an increasing requirement for inotropic support and worsening lactic acidosis the patient was returned to theatre by a consultant for laparotomy. The return to theatre occurred less than two hours after the MET call and the operative findings were of a grossly contaminated abdomen with purulent peritonitis and faecal contamination. An obvious defect at the anastomotic site was noted. The anastomosis was taken as a specimen and an ileostomy fashioned after adequate washout.

The patient developed multiple organ failure. Following discussion with the family a decision was made to withdraw inotropic support and dialysis. The patient died on the eleventh postoperative day.

Comment

The decision for a resection with anastomosis was appropriate, even given the patient's comorbidities. It was made at a multidisciplinary meeting following appropriate preoperative assessment. The deterioration on day five or six postoperatively, in a patient who was otherwise progressing well, should have immediately raised the suspicion that a leak was present. The delay in recognising the leak was approximately 24 hours and earlier detection may have changed the outcome for this patient. The chances of survival were certainly reduced by the 24 hours in which the abdominal sepsis remained undetected.

CASE STUDY 13: LACK OF STAFF DELAYS HAEMODIALYSIS AND LEADS TO DEATH FROM HYPERKALAEMIA

Case Summary

A middle-aged patient was admitted for an elective transposition of the basilic vein for the creation of an AV fistula. The patient also had a diagnostic angiogram and angioplasty 11 days later due to a chronic non-healing ulcer on the left foot. The patient was on regular haemodialysis due to end stage kidney disease. The past medical history and comorbidities were significant, including type II diabetes, right below knee amputation, hypertension, ischaemic heart disease, coronary artery bypass graft (CABG), peripheral neuropathy and diabetic nephropathy. The patient was on ramipril.

The transposition of the basilica vein was uneventful, as was the left leg angiogram and angioplasty. The patient underwent haemodialysis after the angioplasty. A further angiogram and possible angioplasty was required and the patient was scheduled to undergo haemodialysis two days later. However, a lack of capacity in the dialysis unit meant that the haemodialysis was delayed. The nursing progress note stated that there was 'no room' and dialysis was rescheduled for the next morning. Just prior to commencing haemodialysis, and while in the dialysis unit, the patient collapsed. A MET call was initiated and cardiopulmonary resuscitation was conducted. Amiodarone, calcium and glucose were given intravenously during resuscitation but the patient made no improvement and passed away.

Comment

The cause of death was most likely severe hyperkalaemia (8.8 mmol/L) on the background of ischaemic heart disease. The hyperkalaemia may have been prevented had haemodialysis been performed as originally scheduled following the second angiogram. Increased staffing or an extra shift in the dialysis unit on that day may have saved the patient's life.

There is no record in the documentation to indicate that the appropriateness of delaying the haemodialysis had been assessed, or even discussed, by the treating teams. It is also of concern that there was no blood test to check the patient's potassium levels after the haemodialysis was cancelled. This is a significant error in this particular patient, who had a known tendency to hyperkalaemia.

Lastly, the outcome of the resuscitation may have been improved had insulin been administered with the glucose, as is the protocol for treating hyperkalaemia.

CASE STUDY 14: MISSED CAECAL VOLVULUS NOT HELPED BY THE RUSH TO MOVE PATIENT FROM THE ED

Case Summary

A very elderly patient was admitted with a three day history of constipation, constant abdominal pain and abdominal distension. There was a history of admissions for constipation, and previous colonoscopies and endoscopies had revealed the presence of gastric ulcers. The patient's medical history also included surgery for possible pancreatic cancer, a bowel resection and previous hernia repairs. Medications included frusemide, antihypertensives and Plavix (clopidogrel).

Examination revealed generalised abdominal tenderness in an uncompromised patient. Renal function showed a creatinine level of 260 $\mu\text{mol/L}$. An abdominal x-ray was interpreted as showing a dilated small bowel without air fluid levels but with massive faecal loading. Surgical review in the early hours of the morning came to a similar conclusion although the tenderness seemed to have subsided. The primary diagnosis was bowel obstruction secondary to gross faecal loading.

Aperients were prescribed and a medical admission organised. Bowel preparation and Fleet (sodium phosphate) enemas were given the following morning. The enemas were followed by a CT scan that showed a caecal volvulus. The patient was taken to theatre in the evening and a right hemicolectomy was performed with primary anastomosis. The patient was transferred to the ICU but deteriorated. Treatment was withdrawn following discussion with the family.

Comment

There are several areas of concern and consideration that, when put together, may lead to the conclusion that this was an adverse event. On admission this patient had the cardinal signs of obstruction: pain, relative constipation, abdominal distension and vomiting. Indeed, the presumptive diagnosis was obstruction secondary to constipation. The interpretation of the abdominal x-ray would have been difficult because of the previous pancreatic and bowel resections. Air fluid levels would have only been visible if the x-ray film was an erect film, while in cases where the predominant distension is in the large bowel they may not be present.

Patients with abdominal pain requiring opiate analgesia should be considered for a CT scan on admission. The pain was severe enough to require titrated doses of morphine and the vomiting deemed significant enough for the placement of an NGT. The commencement of Colonlytely (polyethylene glycol and electrolyte solution) bowel preparation in this setting was inappropriate, with bowel preparation contraindicated in an obstructive situation.

At surgery, a right hemicolectomy with division of adhesions was performed, the correct procedure for a caecal volvulus. While the pathology report did not show any transmural infarction, it is likely that the attending surgeons were unsure of the viability of the bowel and hence took a judgement call at the time of surgery.

Another area of concern relates to the transfer of this patient from the ED to the ward. This was an elderly patient who had been admitted to the ED very late at night with severe pain. Several echocardiograms (ECGs) were performed during periods of spontaneous tachycardia, the patient's oxygen requirements increased to 6 L/min, and the patient required transfer to the resuscitation room in the early hours of the morning. Despite this,

the patient was transferred out of the ED resuscitation area to the ward in the middle of the night. This was not appropriate, irrespective of the 4-hour rule. While the seniority of the ED doctor who permitted the move to the ward is unclear, this patient was not well enough to be moved, and should have remained in the ED resuscitation area.

CASE STUDY 15: TECHNICAL ISSUES DURING SURGERY SHOULD HAVE BEEN MANAGED DIFFERENTLY

Case Summary

An elderly patient was admitted for an elective fistulogram. This procedure was aborted when the patient developed significant non-ST elevation myocardial infarction (NSTEMI) myocardial ischaemia. The patient received care by the cardiology team, remained stable and had an elective catheter 16 days later.

The cardiac catheter revealed a critical left main stem narrowing, severe left anterior descending (LAD) artery disease, total circumflex and total right coronary artery occlusions, and modest disease of the two diagonals. Left ventricular function was severely impaired at 30%. The patient was accepted for CABG surgery. Mention is made by the cardiology team about the low threshold for inserting an intra-aortic balloon pump (IABP) preoperatively. The procedure was considered low-to-moderate risk by the treating cardiology team.

The patient had a very significant medical history, including: former smoker, type II diabetes, hypertension, significant peripheral vascular disease that had resulted in toe amputations and foot ulcers, and chronic renal failure which had required haemodialysis since 2009. Importantly the patient had a left-sided AV fistula since 2009.

The patient underwent elective CABG surgery 21 days after the planned fistulogram. Included below is a re-creation of key events that took place during the procedure.

1. Anaesthetic induction, although described as stable, was associated with difficulty in establishing central venous access, as well as haemodynamic instability. The latter resulted in the need for high doses of phenylephrine and noradrenaline, as well as the development of new and either recurring or persistent ST segment changes. No mention is made of whether it is elevation, depression or both. There is also no mention of how long it continued, although it appears to be present until cardiopulmonary bypass (CPB) was established several hours later.
2. During surgery the left internal mammary artery (LIMA) graft was considered unsuitable due to poor flow and was discarded. There is no question that the preoperative plan was for this graft to be placed on the LAD.
3. The long saphenous vein was considered suitable.
4. Grafts were done to the old myocardial infarction and the DI. The LAD was searched for but a 'poor target and not found'. It is unclear whether the LAD was found or not. What is known is that it took 44 minutes of cross clamping to perform two grafts.
5. On the first attempt to take the patient off CPB it was noted that the diagonal graft was too tight and the anterior wall was contracting poorly. CPB was reinstated.
6. Additional attempts were made to take the patient off bypass; however the anterior wall was still not contracting due to the diagonal graft remaining too tight.
7. The patient was again returned to CPB. The aortocoronary anastomoses to the diagonal graft was removed from the ascending aorta and reattached to the other saphenous graft. Only now was it not considered to be too tight.
8. Subsequent attempts to take the patient off CPB failed, and an IABP was inserted with great difficulty.
9. Despite various inotropic uses/doses the patient dies on the table from a myocardial infarction. While the type of myocardial infarction is not recorded, it is assumed that this

was an anterior myocardial infarction.

10. No mention is made of the state of the mitral valve.

11. No mention is made of ECG changes throughout the procedure, with the exception of the entry relating to anaesthesia.

Comment

There are several areas of concern associated with this case. This type of patient is not uncommon and is worthy of CABG. This patient had significant medical comorbidities in addition to critical coronary anatomy, a recent myocardial infarction and severely depressed left ventricular function. It would take only a minor mistake to change a salvageable heart with a reasonable medium term prognosis to an unsalvageable one. The surgical and anaesthetic problems that were encountered should not have been unexpected. Careful preoperative and intraoperative planning could have prevented many of the problems, or at the very least minimised their impact.

Use of the IABP

The IABP should have been inserted preoperatively, as alluded to by the cardiology team. It could reasonably have been anticipated that the anaesthetic induction would prove difficult, and that it would cause myocardial ischaemia. The IABP was not inserted when ischaemia became manifest, nor prior to the patient going on CPB. In addition, at no stage was the surgery interrupted so that the patient could go onto CPB despite the high doses of vasoconstrictors required and the ECG changes. It was essential that myocardial ischaemia be avoided, or acted upon immediately once present, as it was going to be a harbinger of global severe myocardial ischaemia in an already compromised heart. There was no attempt to change the course of events through either the insertion of an IABP or the use of CPB.

Difficulty can be expected in inserting an IABP via the femoral artery. The correct process would have been a preoperative insertion in the catheter lab using radiological guidance. This notwithstanding, the patient had known severe peripheral vascular disease, and the most appropriate femoral vessel to receive the IABP should have been determined preoperatively.

It is also unclear as to why the IABP was not inserted following the first attempt to take the patient off CPB. This patient had poor left ventricular function; a recent myocardial infarction; significant myocardial ischaemia from anaesthetic induction; an incompletely revascularised anterior wall; and required ongoing high dose noradrenaline post induction. The patient could not be taken off CPB successfully and yet the IABP was not used until quite late.

Use of the LIMA graft

In a patient with a left-sided AV fistula it is well recognised that a left internal mammary artery (IMA) can be compromised in terms of its flow due to the rapid and substantial run off from the AV fistula. There was no consideration given to using the LIMA as a free graft in the absence of other suitable conduits.

Intraoperative Concerns

Patients with a similar presentation and medical history are often challenging when it comes to the technical aspects of grafting, despite the catheter appearances of their coronary arteries. It is unclear from the operative report whether the LAD was found. However, irrespective of whether it was found the immediate option was to graft the diagonal, which was visible, had moderate disease, and was clearly able to be grafted. A graft to the anterior wall via the diagonal would have minimised the period of cross clamping, preventing time being lost to searching for and possibly damaging the LAD.

Diagonal Graft

During the first attempt to take the patient off CPB it was discovered that the top end of the diagonal graft was too tight. The precarious circulation to the entire anterior wall was now further compromised following a period of aortic cross clamping. This clear technical error should have been addressed immediately that it was noticed. The patient went on and off CPB with ongoing inadequate anterior wall perfusion.

CASE STUDY 16: EMERGENCY OPERATION FOR CHRONIC DISSECTION COMPLICATED BY INTRAVASCULAR COAGULATION

Case Summary

This elderly patient presented to a regional hospital with a history of shortness of breath. There was no history of acute onset chest pain and the D-dimer level was raised at 0.79 mg/L. A computed tomography pulmonary angiogram (CTPA) was performed at 11:00pm. There was no evidence of pulmonary embolism; however the CTPA did show an ascending aortic aneurysm with a maximum diameter of 6.2 cm and a probable luminal dissection flap. An incidental finding of a right lower lobe superior segment spiculated lesion was suggestive for malignancy, however there was no mediastinal disease.

On transfer to a metropolitan hospital the patient was found to be comfortable, with no neurology signs and unremarkable haemodynamics. A further CT angiogram was performed at 10:30am on the morning after the first CTPA. While confirming the presence of the aneurysm it also showed an intimal flap in the ascending aorta, located just above the valve around the arch. There was no propagation down the descending aorta and no haematoma or pericardial fluid was visible.

The cardiothoracic team were consulted however the unavailability of an operating theatre led to the patient being transferred to another metropolitan hospital. On being transferred the patient underwent emergency surgery. Documentation from the surgeon consisted of a brief handwritten note; however the anaesthetist's report provided a more detailed overview of the procedure. The dissection was repaired with CPB and a period of circulatory arrest. The patient was successfully weaned from bypass, but following closure of the chest the pulmonary artery pressures rose, with a decrease in systemic arterial pressures. Transoesophageal echocardiogram (TOE) revealed a normal right ventricle but an empty left ventricle. The chest was reopened and massage commenced while a further pump was primed. TOE also showed severe aortic regurgitation. An additional period of bypass was used while the valve was replaced with a St Jude's prosthesis. On weaning for the second time biventricular failure occurred, and extracorporeal membrane oxygenation (ECMO) was commenced. Initial good flows decreased dramatically. A blood clot was seen within the right atrium and resuscitation attempts were abandoned.

Comment

It is somewhat disconcerting that the metropolitan hospital to which the patient was initially transferred did not have operative facilities available. The hospital was informed of the transfer patient's scheduled arrival the day before the transfer took place.

One area of consideration is that an emergency operation was performed on what was evidently a chronic rather than acute dissection. The absence of chest pain and the haemodynamic stability of the patient, as well as the patient's medical history, were all strongly suggestive of a chronic pathology. While an elective repair would have been required, it would have been performed within office hours and this may have resulted in a better outcome.

The principal adverse event was the discovery of thrombus following the first period of bypass. The surgeon stated that tranexamic acid was given after the period of circulatory arrest, and that this may have contributed to the pro-coagulant state. The patient's activated clotting times following the initial period of bypass were as expected, and were in no way abnormal. The dose of protamine was appropriate. This patient became highly pro-

coagulant, which led to the aortic regurgitation and haemodynamic compromise. The anaesthetist's report provided a thorough overview of the anticoagulation management during both the first and second periods of bypass, and it would appear that this was managed appropriately. During the re-exploration a clot was found in the aortic root that was sticking the aortic leaflets together. Other clots were also found around the coronary orifices. The finding that clots were sticking the aortic leaflets together raises the question of whether a replacement for the valve was actually required.

There was also no evidence that more advanced measures of coagulation, such as ROTEM or TEG, were used in this case. It also was somewhat surprising that despite this finding the ultimate demise was due to thrombosis of the ECMO circuit; however, there was significant bleeding recorded and large amounts of blood products were given, so the possibility of disseminated intravascular coagulation also arises. The use of ROTEM would almost certainly have assisted in the management of this patient's hypercoagulable, and then hypocoagulable, state.

CASE STUDY 17: INADEQUATE PREOPERATIVE WORKUP

Case Summary

A very elderly patient with a large seven centimetre popliteal aneurysm underwent surgical repair with Polytetrafluoroethylene Membrane (PTFE). A preoperative bedside echocardiogram on the day of surgery found severe aortic stenosis, with a gradient greater than 80 mm Hg, but normal left ventricular function.

While the operative note is scant, the duration of the procedure and blood loss suggest that the operation was complex. The surgical procedure took over three hours. Postoperatively the patient was hypotensive and unstable. The patient was transferred to the ICU and was resuscitated and stabilised. The preoperative haemoglobin of 146 g/L fell to 105 g/L in the ICU, and to 75 g/L a few days later. Despite this the patient refused transfusion and was discharged to the ward on the second postoperative day.

A postoperative cardiology consultation, including a formal echocardiogram, confirmed severe aortic stenosis, but also found severe left ventricular dysfunction and a left ventricular ejection fraction of 24%. On the fifth postoperative day the patient collapsed and was transferred to the critical care unit. The patient died early the next day following an arrest.

Comment

For this case the primary concern relates to the adequacy of the preoperative assessment and the influence of the bedside echocardiogram. The bedside investigation was undertaken just before the scheduled operation and in the face of pressure arising from the expectation to proceed.

The discrepancy between the bedside and formal echocardiogram is significant. At its simplest, the question must be asked as to whether the operation would have proceeded if the findings of the formal echocardiogram had been known.

A less rushed schedule of investigation may have led to a different decision being made. The refusal of the patient to accept a blood transfusion is a significant factor that contributed to cardiac stress, although the magnitude of this is not accurately quantifiable.

CASE STUDY 18: NON-TECHNICAL MANAGEMENT COULD HAVE BEEN DIFFERENT

Case Summary

An elderly patient underwent a left common femoral endarterectomy. A (possible bovine) pericardial patch was used to close the angiotomy. The patient was a former smoker with a history of ischaemic heart disease, pulmonary disease, hypertension and alcohol excess. The patient was discharged a few days later without any obvious perioperative complications or concerns. Documentation was not available regarding the premorbid state of the patient, the indications for surgery or details of the surgical procedure.

Four weeks later the patient presented to a different hospital with a one day history of fever, disorientation and the sudden onset of severe pain, swelling and erythema in left groin. On examination there was a large tender pulsatile swelling in the left groin underlying the recent surgical wound. An ultrasound confirmed a large haematoma, and although no flow was seen within the haematoma, the sonographers commented that it was likely to represent a false aneurysm.

The patient was started on antibiotics. A cardiology opinion was requested in view of the patient's past cardiac history and an incidental rise in troponin level. The patient had not reported experiencing any chest pain and there were no ECG changes. Formal anticoagulation with heparin and aspirin was commenced by the cardiac team, after discussion with the vascular team. Twenty-four hours later the heparin was stopped as the groin haematoma had enlarged considerably. Repeat ultrasound and CT angiograph showed a large false aneurysm with flow inside.

The next day the false aneurysm was repaired with a partial removal of the patch and insertion of a vein interposition graft. The patient recovered slowly over the next two weeks. The slow recovery appears to have been due to general frailty, the presence of comorbidities and initial problems with delirium. A routine CT scan showed no leak and discharge plans were considered.

Nineteen days after the false aneurysm was repaired the patient suffered a sudden bleed from the groin wound, and an urgent exploration was undertaken by the on-call vascular surgeon. Several bleeding points on the artery and patch were oversewn. The following day there was an additional large bleed from the wound and it became necessary to ligate the common femoral artery. The patient's leg became profoundly ischaemic following the surgery and, after discussion with the family, the decision was made to palliate the patient.

Comment

The groin is an area with a higher risk of infection. Catastrophic failure of patch angioplasty, in the presence of infection, is a well-known risk. However, failure of an autologous vein graft is unusual when compared to prosthetic grafts. The outcome and infection resistance of alternative grafts, such as bovine pericardium, is much less well known. Their use for primary endarterectomy is still relatively uncommon in Australia.

A key question is whether antibiotics were given at the time of the first operation. Failure to do so would represent an important oversight. However, in the absence of perioperative or progressive notes relating to the first operation (the femoral endarterectomy) it is not possible to determine whether antibiotics were used. This also means that the rationale for the use of a pericardial patch is not clear in this instance. These issues may have been able to be resolved had the primary operating surgeon associated with the patient's first

admission completed the surgical case form. While death of the patient may have been unavoidable, ultimately it occurred as a direct result of the first operation.

The patient in question was a cardiopath and was rapidly reviewed by the cardiologists on admission. The presence of raised troponin levels led to the belief that an acute NSTEMI was likely, despite the absence of chest pain or ECG changes. Formal anticoagulation with heparin and aspirin was commenced following discussion with the vascular team. In a patient with a suspected infected false aneurysm the decision to commence full anticoagulation on this basis is questionable. However, the use of anticoagulation is unlikely to have significantly changed the outcome on this occasion.

CASE STUDY 19: WAS URGENCY OF ERCP IMPORTANT?

Case Summary

An elderly smoker with asthma was seen in the ED at lunchtime with a one day history of epigastric pain radiating to the back. The patient was tachycardic but afebrile. The ED doctors assessed the patient as septic from pancreatitis or cholecystitis and a surgical opinion was requested. In the early afternoon the patients' temperature was 39°C, and WBC $8 \times 10^9/L$. Lipase and liver function test (LFT) results were raised, with a bilirubin of 51 $\mu\text{mol/L}$. Over the next six hours the patient was resuscitated but remained febrile, tachycardic and the BP was labile.

In the early evening a general surgeon reassessed the patient and noted the cholangitis. It was determined that the patient should have a CT scan and endoscopic retrograde cholangiopancreatography (ERCP), as well as be admitted to the ICU. The radiologist initially declined the CT scan, suggesting an ultrasound be performed the next morning. However, the CT scan was eventually performed following intervention by a consultant surgeon. The scan showed large a gallstone with cholecystitis, pancreatitis with peripancreatic oedema, and a 9 mm common bile duct (CBD). There were no obvious CBD stones. In the late evening the gastroenterology registrar suggested that the patient be given 12 hours of IV antibiotics followed by ERCP, and the patient was admitted to the ICU.

The patient underwent ERCP the following morning at 11:00am. The procedure was difficult due to oedema and swelling, and cannulation of the CBD was impossible. Pus was seen extruding from the papilla and a knife papillotomy was performed. It was suggested that a repeat ERCP or surgery be considered. *Escherichia coli* (sensitive to the prescribed Tazocin (piperacillin/tazobactam)) was identified in the blood cultures.

Over the next four days the patient's condition continued to improve with antibiotics and ICU support, although ventilation was difficult due to a left pleural effusion. LFTs and inflammatory markers improved and further ERCP was deemed unnecessary. The pleural effusion was drained but there was difficulty in maintaining oxygen saturation as the patient could not tolerate bilevel positive airway pressure.

On the eighth day following admission the patient developed fresh per rectal bleeding. The patient was haemodynamically stable (haemoglobin 92 g/L) and was started on IV pantoprazole. Later that day there was a further bleed, and a surgical review suggested that it was a diverticular bleed. The patient was transfused two units of blood. Melaena was documented by a nurse on the ninth day. The patient, who was already off all inotropes, remained stable. Haemoglobin levels were also stable.

The following day the patient's respiratory condition deteriorated. The patient became hypotensive and the inflammatory markers increased. The haemoglobin was 62 g/L and WBC $32 \times 10^9/L$. A CT scan reported cholecystitis, peripancreatic oedema and bilateral basal consolidation. Bronchial aspirate grew *E.coli*. Inotropic support was restarted and the requirements for this support increased over the next few hours. Following discussions between the ICU, surgery and gastroenterology teams, and the family, it was decided that treatment should be capped. Support was withdrawn on the eleventh day after admission and the patient passed away.

Comment

A key question is whether the delay in performing the ERCP in the presence of sepsis may have contributed to the patient's death. The Surviving Sepsis Campaign reports better

outcomes for patients who present with septic shock and undergo source control within the first six hours.¹ A recent study found that subjects with moderate to severe ascending cholangitis, who underwent ERCP or percutaneous biliary drainage, had a lower risk of hospital mortality when biliary drainage was performed within eleven hours of admission, compared with later than forty-two hours after admission. However, no difference was found between drainage being performed eleven hours and twenty-four hours after admission.² In terms of this patient, there is no evidence to suggest that an earlier ERCP would have altered the outcome.

CASE STUDY 20: COMBINED SURGERY WOULD HAVE BEEN PREFERRED

Case Summary

This elderly patient was a Jehovah's Witness with a background history of a cerebrovascular accident (no residual deficits) factor V Leiden mutation, type II diabetes, hypertension, hypercholesterolaemia, peripheral vascular disease, and ankylosing spondylitis requiring long-term steroid use.

An ultrasound and CT scan of the abdomen were performed to investigate an abdominal mass, revealing a right renal mass that possibly involved adjacent bowel. The patient was referred to a urologist, who recommended a nephrectomy based on the provisional diagnosis that this was a locally invasive transitional cell carcinoma. The patient was admitted the day before surgery. Appropriate discussion was undertaken with a haematologist and their recommendations were followed with regards to perioperative DVT prophylaxis.

The operative findings confirmed the CT scan. The second part of the duodenum was breached and an upper gastrointestinal surgeon was called to help with the resection. The transverse colon was also involved. A wedge resection of the involved duodenum and a right hemicolectomy were performed by the upper gastrointestinal surgeon. Reconstruction was performed with a Roux-en-Y duodeno-jejunostomy and an ileocolic anastomosis.

The patient was admitted to the ICU for drowsiness and discharged to the HDU and then to the ward on day three. Jejunostomy feeds were commenced. There were issues with postoperative delirium. Bile-stained fluid was found draining from the laparotomy wound and drain during the morning of day four, and 90 minutes later the patient was returned to theatre. A leak from the posterior aspect of the duodeno-jejunostomy was found and there was moderate contamination in the right upper quadrant. Washout was performed and a T-tube was inserted into the leak defect.

The patient remained in the ICU for six days before being transferred to the HDU. At the time of transfer to the HDU the patient had abdominal sepsis which was under control; acute renal injury which did not require haemofiltration; cardiac ischaemia due to anaemia; pleural effusion and postoperative confusion. An interval CT scan of the abdomen performed 13 days after the first operation showed a moderate amount of free fluid on the right side of the abdomen but no drainable collection. Drains were still in situ and one of the drains had a high volume of serous fluid. The patient had been on total parenteral nutrition all this time.

A lymphoma was confirmed by histology. Haematology was consulted. On day 14 there was clinical deterioration of the patient with tachypnoea and metabolic acidosis. The surgical consultant felt that no reversible surgical issues were present and no intervention was offered. The haematologist felt that the deterioration may be due to the lymphoma itself (tumour lysis) and recommended that chemotherapy should commence. A MET call was placed four days after the patient started chemotherapy, and it is likely that the call was due to sepsis as *Enterococcus* was found growing in the blood cultures. The patient continued to deteriorate and was palliated following discussion with the family.

Comment

It may have been preferable to involve the upper gastrointestinal surgeon at the start of the operation. Given the preoperative imaging it would have been reasonable to anticipate the need to excise the involved duodenum and other involved bowel.

The timing of the chemotherapy is also questionable, and whether the patient had recovered sufficiently prior to the commencement of chemotherapy. The haematologist felt that the clinical deterioration that occurred after the second laparotomy, and 14 days after the first procedure, was due to tumour lysis. However, it is likely that the chemotherapy hastened the eventual outcome.

CASE STUDY 21: POSTOPERATIVE ANTICOAGULATION – NOT ALWAYS POSSIBLE TO GET RIGHT

Case Summary

A very elderly nursing home resident was admitted with a left displaced sub capital fractured neck of femur following a mechanical fall. The patient was on warfarin for AF and had an international normalised ratio (INR) of 2.1 on admission. The past medical history included a previous cerebrovascular accident and hypertension. Vitamin K was given on admission and the standard neck of femur pathway process instigated. A femoral nerve catheter was inserted by the anaesthetic team to provide pain relief.

The following day a cemented Exeter hemiarthroplasty was carried out via a Hardinge anterolateral approach. The surgery was uneventful from an orthopaedic point of view, but the patient was noted to have ECG changes and intraoperative monitoring changes consistent with an ST elevation myocardial infarction (STEMI). The patient was discussed with the cardiology team and a decision was made, involving consultation with the surgeons, anaesthetist and cardiologists, to commence aspirin and IV heparin immediately following surgery. Clopidogrel was withheld at that stage due to the already increased risk of bleeding associated with the administration of aspirin and heparin.

The patient continued to have wound ooze in the first 12 days after surgery, and was taken to theatre on postoperative day 12 for a haematoma washout. The microbiology samples from theatre at this stage grew *Staphylococcus epidermidis*, *Staphylococcus capitis* and *Enterococcus faecalis*. Eight days following the initial washout the patient was taken to theatre for a first stage revision and insertion of an antibiotic-impregnated cement spacer. The patient continued to deteriorate over the following six days despite full active management, and developed signs and radiology in keeping with some form of abdominal perforation. In liaison with the general surgery team the decision was taken to manage the patient conservatively. The patient died 26 days after the initial procedure, with perforated duodenum listed as the cause of death.

Comments

A cemented hemiarthroplasty in a very elderly patient is a very high risk procedure. In this case the patient developed a substantial haematoma that subsequently became infected, necessitating two further visits to theatre. The physiological stress associated with the haematoma, and return visits to theatre, is likely to have contributed significantly to the patient's duodenum perforation and subsequent death.

There was good evidence that the patient had experienced an intraoperative STEMI and this was recognised by the anaesthetic team. The on-call cardiology team was involved promptly and appropriately, and the treatment for the STEMI recommended by the cardiology team was a combination of aspirin, clopidogrel and heparin. This combination of medical treatment is ideally instigated as soon as possible after the diagnosis of a myocardial infarction. However, in this case there were two competing priorities in the immediate postoperative period: protect the patient from ongoing myocardial infarction and prevent excessive postoperative bleeding and haematoma formation.

There was no right or wrong decision in terms of commencing anticoagulation therapy. The key point is that the decision was made at a senior level between surgeon, anaesthetist and cardiologist. Withholding of the clopidogrel was a sensible compromise. Overall, this was a measured and carefully considered response to a difficult situation. It should also be acknowledged that the record keeping in this case was very thorough.

CASE STUDY 22: INADEQUATE PREOPERATIVE REVERSAL OF ANTICOAGULATION

Case Summary

This very elderly patient was admitted with acute acalculus cholecystitis. The patient had significant comorbidities and was on anticoagulation therapy. Conservative management of the patient was unsuccessful and the patient underwent surgery four days after admission. A laparoscopic cholecystectomy was initially performed however bleeding necessitated conversion to open surgery. The patient died postoperatively due to haemorrhagic shock.

Comment

There were some aspects of this patient's care which could have been different, including the timing of the decision to operate, and the degree to which the anticoagulation had been reversed prior to surgery. However, it is unlikely that changes in either area would have affected the patient's outcome. The patient's WBC was $24.6 \times 10^9/L$ and CRP 263 nmol/L on admission, and values at this level raise the possibility of either gangrene or empyema. If present, both conditions would likely have required intervention. As the underlying pathology was cholecystitis with ischaemia, a percutaneous cholecystostomy may not have worked as well as an empyema of the gall bladder. While the decision to operate was most likely correct, the diagnosis of acute acalculus cholecystitis meant that this decision should perhaps have been made earlier.

Inability to control the patient's bleeding during the laparoscopic cholecystectomy resulted in a conversion to open surgery. At the time the operation was performed the patient's INR was still high (1.7) despite preoperative administration of vitamin K. Full reversal of the anticoagulation could easily have been achieved in the four days between admission and surgery. There was no record of a haematologist being consulted or discussion of the possible use of Prothrombinex®-VF to achieve the reversal. Fresh frozen plasma was given intraoperatively.

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SHORTENED FORMS

µmol/L	micromoles per litre
AF	atrial fibrillation
AV	arteriovenous
BP	blood pressure
CABG	coronary artery bypass graft
CBD	common bile duct
cm	centimetre
CPB	cardiopulmonary bypass
CRP	C-reactive protein
CT	computed tomography
CTPA	computed tomography pulmonary angiogram
DVT	deep vein thrombosis
ECG	echocardiogram
ECMO	extracorporeal membrane oxygenation
ED	emergency department
ERAS	enhanced recovery after surgery
ERCP	endoscopic retrograde cholangiopancreatography
g/L	grams per litre
HDU	high dependency unit
IABP	intra-aortic balloon pump
ICU	intensive care unit
IMA	internal mammary artery
INR	international normalised ratio
IV	intravenous

L	litre
L/min	litres per minute
LAD	left anterior descending (artery)
LFT	liver function test
LIMA	left internal mammary artery
LMWH	low molecular weight heparin
m	metre
MET	medical emergency team
mL	millilitre
mm	millimetre
mm Hg	millimetres of mercury
mmol/L	millimoles per litre
NGT	nasogastric tube
nmol/L	nanomoles per litre
NSTEMI	non-ST elevation myocardial infarction
RACS	Royal Australasian College of Surgeons
RMO	resident medical officer
STEMI	ST elevation myocardial infarction
TOE	transoesophageal echocardiogram
WBC	white blood cell count