

Laparoscopic Cholecystectomy in a Left Ventricular Assist Device-Supported Patient

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Left ventricular assist devices are becoming an increasingly accepted treatment for end-stage heart failure. Among the many challenges facing physicians treating LVAD patients is how to cope with non-cardiac surgery. We describe our management of an LVAD-supported patient who required laparoscopic cholecystectomy.

PATIENT DESCRIPTION

A 40 year old man experienced severe heart failure due to ischemic dilated

cardiomyopathy after an extensive inferior-posterior myocardial infarction at the end of 2009. The patient remained with poor left ventricular function and advanced heart failure requiring repeated hospital admissions and inotropic support for his heart failure syndrome. After consideration of the treatment options, the patient was registered as an urgent candidate for heart transplantation; eventually, due to clinical deterioration, a Thoratec™ HeartMate II left ventricular assist device (USA) was implanted as a bridge to heart transplantation [Figure]. The HeartMate II is a high speed, electric, axial flow, rotary blood pump. The pump drains blood from the left ventricular apex via a rigid inlet cannula and ejects it into the aortic root via an outflow cannula joined to the aorta with an end-to-side anastomosis. The pump's power and control are delivered through a percutaneous cable from the pump to a belt-worn external system controller and power supply (batteries or external power source).

Twenty-five days after the HM-II implantation, the patient was discharged home at New York Heart Association Class level 1 and resumed his normal activities. Nine months post-surgery the patient experienced an episode of abdominal pain with increased white blood cell count (15,600/mm³), elevated serum amylase (1272 U/L) and abnormal liver function tests (aspartate aminotransferase 172 U/L, total bilirubin 1.7 mg/dl, alkaline phosphatase 135 IU/L) but without concomitant fever or chills. An ultrasound of the abdomen and computed tomography demonstrated gallbladder stones with surrounding fluid

and no dilatation of the extrahepatic bile ducts or pancreatic necrosis. A diagnosis of gallstone cholecystitis and pancreatitis was made and the patient's condition improved with conservative care comprising antibiotics and a low fat diet. However, a second bout of cholecystitis and pancreatitis occurred and a decision to perform cholecystectomy was reached despite the significant risk associated with anesthesia and surgery in an LVAD patient.

The surgical plan was devised by consultation with the laparoscopic and cardiac surgeons who advised regarding the entry ports for laparoscopy in order to avoid disruption of the driveline that runs horizontally and extraperitoneally across the upper abdomen.

The patient's oral anticoagulation medication was switched to low molecular weight heparin, given up to 12 hours prior to the surgery. Aspirin was maintained throughout the entire hospital course.

In the operating room, intravenous vancomycin (1 g) and amikacin (1 g) were given for LVAD endocarditis prophylaxis. To facilitate the arterial line insertion, we reduced the LVAD speed to the minimal value, which enabled palpation of the peripheral pulse. Anesthesia was induced with titrated doses of fentanyl (total dose 150 µg) and propofol (total dose 150 mg), and muscular paralysis was achieved with atracurium (30 mg). A drop in blood pressure following induction was treated with phenylephrine. Anesthesia was maintained with sevoflurane. In addition to the standard monitoring and direct arterial pressure, transesophageal echocardiogram was used to monitor the position and flow through the inflow

Chest X-ray showing a HeartMate II left ventricular assist device



LVAD = left ventricular assist devices

HM-II = HeartMate II

cannula of the LVAD. The TEE allowed us to ensure that the creation of a pneumoperitoneum did not affect the inflow cannula or twist it due to increased sub-diaphragmatic pressure. During the surgical procedure, LVAD function was supervised by the heart failure cardiologist in the LVAD team.

For the surgical approach the laparoscopy ports had to be modified to avoid the LVAD cable, but this did not cause any surgical difficulties. The operation itself took 25 minutes and required three trocars (10 mm trocar in the umbilical area and 10 and 5 mm trocars in the right hypochondrium). An intraperitoneal drain was left in place to ensure the return of full anticoagulation. At the end of the procedure residual neuromuscular blockade was reversed with myostigmine (2.5 mg) and atropine (0.5 mg), and the patient was extubated and transferred to the post-anesthesia care unit for overnight monitoring. Heparin was resumed 6 hours post-surgery, aiming for a partial thromboplastin time of 40–50 seconds, and oral anticoagulation was restarted on the same day. The abdominal drain was removed after 24 hours during which increasing amounts of anticoagulation were given. The patient recovered uneventfully and was discharged home after 3 days of monitoring in the cardiology ward during which a therapeutic prothrombin time was achieved.

COMMENT

We describe an LVAD patient who required laparoscopic cholecystectomy for symptomatic gallstones. We presumed the cause of the gallstone was related to low grade intravascular hemolysis, which is known to occur with LVAD use.

TEE = transesophageal echocardiogram

Performing non-cardiac surgical procedures in LVAD patients represents a unique challenge given the anatomic, hemodynamic and hematologic considerations in these patients. Only a few reports have described such procedures. In the past, non-cardiac surgical procedures were required to treat complications of the LVAD implantation procedure, such as LVAD pocket and sternal wound infection [1]. However, over time, both urgent and semi-elective procedures for more “standard” indications were described in sporadic case reports and a few small case series [2]. Evaluation and management of abdominal pathology in patients with ventricular assist devices is likely to become increasingly important with greater utilization of these devices [3]. Although hemolytic anemia is not common with the axial flow devices, it does occur and secondary gallstones may be prevalent more often than in a matched healthy population. The axial LVADs, such as HM-II, are accompanied by lower levels of haptoglobin and hemopexin and higher levels of free hemoglobin and lactate dehydrogenase when compared with intracorporeal centrifugal pumps. Surprisingly, only a few case reports have been published on cholecystectomy in LVAD-supported patients [4].

As evidenced by our case, meticulous preparation and close team work are required to complete the procedure successfully. Avoiding any interruption to the tunneled abdominal cable is crucial. Another important issue is anticoagulation. The anticoagulation protocols post-LVAD implantation have changed significantly since the first described protocol [5] and it appears that HM-II may tolerate lower rates of anticoagulation. Accordingly, heparin cannot be restarted postoperatively if significant bleeding

occurs or if the laparoscopic approach had to be converted to an open laparotomy due to a laparoscopic complication.

We wish to address a concern that we had preoperatively, namely the need to watch the inflow cannula abdominal insufflation for the laparoscopic procedure. Although we did not observe any cannula interruption or flow impairment in our patient, it could be a potentially life-threatening complication.

In summary, the need for non-cardiac surgical procedures is likely to rise. Meticulous preparation by the “LVAD team” together with the relevant surgical discipline, along with careful consideration of anticoagulation and monitoring issues, are necessary to carry these complex patients safely through these procedures.

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References

- Goldstein DJ, Mullis SL, Delphin ES, et al. Noncardiac surgery in long-term implantable left ventricular assist-device recipients. *Ann Surg* 1995; 222 (2): 203-7.
- Garatti A, Bruschi G, Colombo T, et al. Noncardiac surgical procedures in patient supported with long-term implantable left ventricular assist device. *Am J Surg* 2009; 197 (6): 710-14.
- Amir O, Aravot D, Pizov R, et al. Permanent left ventricular assist device for end-stage heart failure: first successful implantation of the axial flow HeartMate II rotary pump as destination therapy for heart failure in Israel. *IMAJ Isr Med Assoc J* 2007; 9: 887-9.
- Livi U, Guzzi G, Tursi V, et al. Laparoscopic approach for urgent abdominal surgery in patients with left ventricular assist devices. *J Cardiovasc Med (Hagerstown)* 2009; 10 (9): 741-4.
- Amir O, Bracey AW, Smart FW, Delgado RM 3rd, Shah N, Kar BA. Successful anticoagulation protocol for the first HeartMate II implantation in the United States. *Tex Heart Inst J* 2005; 32 (3): 399-401.

After science has done its best the mystery is as great as ever, and the imagination and the emotions have just as free a field as before

John Burroughs (1837-1921), American naturalist and essayist who played a key role in the evolution of the U.S. conservation movement

These research projects, undertaken in partial fulfillment of the requirements for the MD degree at Sackler Faculty of Medicine, Tel Aviv University in 2011–2012, were considered the most outstanding of the graduating class

Does gear weight reduction and design reduce the prevalence of stress fracture in border police recruits during basic training? A prospective study

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Background: Overuse injuries are responsible for two-thirds of all exercise-induced injuries. Stress fractures, the most important injury in this group, not only compromise the ability of the soldiers to function and hinder their training, but can cause long-term or permanent health disorders. These injuries also have a negative economic impact since they necessitate special medical investigations and absent the soldiers from active service. In female recruits in the Israel Border Police a high incidence of such injuries was shown. For the last 11 years female soldiers have been followed for stress fracture incidence during basic combat training in the Border Police. Both internal and external risk factors were studied and various interventions were implemented to reduce the incidence, but only partial results were achieved.

Objectives: The aim of our study was to reduce the incidence of stress fractures among female recruits in the Border Police by lowering the weight they carry and positioning it closer to the body's center of gravity.

Methods: A prospective study followed 213 female recruits of the Israel Border Police over 4 months of basic training for stress fracture incidence. They were training with modified fighting gear; the modifications included a shorter M16 rifle and a lighter and closely fitted combat vest. Follow-up included questionnaires and bimonthly assessment by the research team. Stress fractures were diagnosed by bone scintigraphy when clinically indicated. The incidence of stress fractures in the intervention group was compared to that in a historical control group of 1210 previous recruits who had trained with the traditional equipment and were followed by the same research group in previous years.

Results: Reducing the weight of the equipment and positioning it closer to the body's center of gravity decreased the incidence of stress fractures from 18.3% in the control group to 7.9% in the intervention group ($P < 0.0001$). A similar decrease was shown in long bones of the lower extremities.

Conclusions: Emphasis should be placed on external modifications to lower the prevalence of stress fractures. A significant effect was achieved by reducing equipment weight and changing its configuration.

The effect of hyperbaric oxygen therapy on amphotericin B-induced acute renal failure in rats

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Background: Acute reduction in renal function is a common and serious side effect of amphotericin B (AmB) administration. The hypothesized injury mechanism is renal vasoconstriction and direct toxic damage to the tubular cell membrane. Hyperbaric oxygen therapy (HBO) is indicated for treatment of many ischemic events but not for acute renal failure (ARF). The present study was designed to examine the effects of HBO on kidney function in rats with AmB-induced ARF.

Objectives: The aim of this study was to investigate how the use of HBO therapy after AmB-induced ARF affects kidney function.

Methods: Acute renal failure was induced in 40 Sprague-Dawley rats by a single dosage of 75 mg/kg AmB administered in a single intraperitoneal injection. The rats were randomly divided into two groups: one group was treated with daily HBO for 60 minutes at a pressure of 2 atmospheres for 3 consecutive days, while the other, control, group did not receive any HBO treatment. Parameters of renal function were measured in both groups, from urine samples on the 4th day after AmB administration and from blood samples on the 5th day after AmB administration.

Results: HBO treatment improved renal function in rats suffering from AmB-induced renal injury; this improvement was statistically significant. Serum creatinine values decreased from 0.70 ± 0.22 mg/dl to 0.49 ± 0.13 mg/dl ($P = 0.001$) and serum urea values decreased from 368.01 ± 169.35 to 200.63 ± 87.82 mg/dl ($P = 0.001$). Rat body weight loss following the administration of AmB was significantly reduced: rats treated with HBO lost $13.5 \pm 14.7\%$ body weight, compared to 24.6 ± 5.2 ($P = 0.004$) in rats

not treated with HBO. Serum magnesium levels decreased from 5.29 ± 1.47 to 3.87 ± 0.83 mg/dl ($P = 0.0001$). Serum sodium and potassium levels were not statistically different between the groups. In addition, no statistically significant differences were measured in urine biochemical studies.

Conclusions: In this model of AmB-induced ARF in rats, HBO treatment alleviated renal injury as reflected by changes in serum creatinine and urea levels. However, more studies are needed to evaluate the importance of HBO treatment in medication-induced acute renal failure.

The effect of vitamin D and FTS on hepatic stellate cell proliferation and cell cycle

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Background: Hepatic fibrosis represents a process of healing and scarring in response to liver injury for several reasons. Hepatic stellate cells (HSCs) play a key role in the formation of hepatic fibrosis. In response to liver injury, HSCs undergo an activation process in which they become highly proliferative and synthesize extracellular matrix. The active form of vitamin D, 1,25-dihydroxyvitamin D₃ [1,25(OH)₂D₃], is an endocrine hormone whose classic role is the maintenance of calcium homeostasis. It has been established that vitamin D also has antiproliferative and pro-differentiation effects in cancer cells and an immune modulator effect. In a previous study in our lab, vitamin D inhibited the development of liver fibrosis. Another substance found to inhibit hepatic fibrosis is farnesylthiosalicylic acid (FTS). FTS inhibits the activation

of Ras, a proto-oncogene that plays an important role in cell proliferation and differentiation. Several studies have shown increased Ras expression during cirrhosis in the livers of patients and animal models.

Objectives: The aim of this study was to establish what effect the combined treatment of vitamin D and FTS has on the proliferation and cell cycle of HSCs.

Methods: The experiments were performed on primary HSCs isolated from rat livers. The cells were spontaneously activated in culture growing on plates for 14 days. The cells were treated with vitamin D, FTS and platelet-derived growth factor (PDGF) in various combinations. Proliferation was tested by using the crystal violet dye and BrdU. Expression of the cell proliferation marker cyclin D1 was tested by western blotting. The influence of the various treatments on the level of activated Ras protein (Ras GTP) was also tested.

Results: Our results show that the ~50% rise in proliferation of HSCs induced by PDGF was inhibited by the combined treatment of vitamin D and FTS by ~65%. Using vitamin D as the sole treatment inhibited the proliferation by ~35%, while FTS as the sole treatment inhibited the proliferation of the HSCs but not in a significant manner. Results of the cyclin D1 measurements were in concordance with the proliferation results. PDGF induced a rise of 60% in the expression of cyclin D1. The combined treatment of vitamin D and FTS lowered the levels of cyclin D1 by ~38%. Use of vitamin D as the sole treatment lowered the levels of expression by ~25%, while FTS as the sole treatment did not inhibit the expression of cyclin D1 in a significant manner. No difference was found in the levels of Ras-GTP after 24 hours exposure to the various combinations of treatments.

Conclusions: These results imply that the combined treatment of vitamin D and FTS inhibits the proliferation of primary HSCs more than vitamin D or FTS as sole agents. The combined treatment might therefore be more effective as a treatment designed to prevent liver fibrosis.

Erratum

In the article "Radical trachelectomy: a fertility-sparing option for early invasive cervical cancer" by Mejia-Gomez et al., which appeared in the May issue (2012; 14: 324-8), a mistake occurred in the second author's name. The correct spelling is Tomer Feigenberg and not Tomer Feigenber as printed.

An important scientific innovation rarely makes its way gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning

Max Planck (1858-1947), German theoretical physicist who originated quantum theory, which won him the Nobel Prize for Physics in 1918. This theory revolutionized our understanding of atomic and subatomic processes, just as Einstein's theory of relativity revolutionized our understanding of space and time. Together they constitute the fundamental theories of 20th century physics, challenging the most cherished philosophical beliefs, and both have led to industrial and military applications that affect every aspect of modern life