Egyptian Journal of Surgery Vol. (21), No. (1), Jan., 2002

VENOUS FOOT PUMP PREVENTS VENOUS STASIS DURING LAPAROSCOPIC BARIATRIC SURGERY

By
Hany Aly Nowara M.D, FRCS & Hany Samy** M.D.*
*Assistant professor of Surgery, Cairo University, ** Assistant professor of Radiology, Cairo University.

Background: *Sixty patients were included in a prospective randomized trial to evaluate the efficacy of AV-Impulse venous foot pump (AVI) of the lower extremities in preventing venous stasis during laparoscopic adjustable banding for obesity.*

Methods: *The study included 60 patients with morbid obesity & were divided into two equal groups, the first group the AV-impulse venous foot pump (+AVI) was used to decrease venous stasis and not used in the second group (-AVI). Both groups had prophylactic low molecular weight heparin. Peak flow velocity (PFV) and cross- sectional area (CSA) of the right femoral vein were measured by Doppler ultrasound before, during, and after pneumoperitoneum with 14 mm Hg.*

Results: *PFV was 26.3 cm/s and CSA was 1.03 cm^2 before peumoperitoneum was induced. During abdominal insufflation, PFV decreased to 60% of the baseline value in the (-AVI) group but remained unchanged in the (+ AVI) group ($p<0.05$). CSA increased to 113% of the baseline in the (-AVI) group and did not change in the (+AVI) group ($p<0.01$). PFV and CSA returned to baseline values within 5 min after abdominal desufflation.*

Conclusions: *AV-Impulse system (AVI) effectively neutralizes venous stasis during laparoscopic surgery and may decrease the risk of postoperative thromboembolic complications. Therefore, it is recommended for all prolonged laparoscopic procedure especially for obese at high risk of developing thrombosis.*

Key words: *Laparoscopic banding – pneumoperitoneum –foot pump– thrombosis – prophylaxis*

INTRODUCTION

The pneumperitoneun currently used for laparoscopic surgery such as bariatric procedures causes marked reduction of the venous blood return from the lower extremities [1-3] and thus may increase the risk of thromboembloic complications. In addition, obese patients undergoing bariatric surgery are at high risk of developing fatal pulmonary embolism, however there is still no clear consensus among physicians about the best prophylactic approach despite the increasing number of bariatric surgical procedures [4].

AV- impulse venous foot pump (AVI) is a simple and reliable technique to increase venous blood return in patients at risk for thrombosis. This technique has been used successfully in conventional abdominal surgery and traumatology for many years [5-12].

The hypothesis of this study was that a pneumoperitoneum with 14 mm Hg reduces venous blood flow from the lower extremities by > 30% and that AVI would neutralize this negative effect of pneumoperitoneum. The focus of this study was the evaluation of venous blood return from the lower extremities during laparoscopic adjustable banding, as measured by Doppler ultrasound.

PATIENTS AND METHODS

Sixty patients with morbid obesity of Body Mass Index (BMI) above 40 Kg/mt^2 were included in a prospective randomized trial.

Surgical technique

All patients were placed in a supine position, and the AVI device was attached to the patient's feet (Fig. 1). In all patients, laparoscopic banding was done in the anti-Trendelenburg position using a four trocars technique [13]. The abdomen was insufflated with CO_2, and the pneumoperitoneum was kept at 14 mm Hg during the entire operation.

AV- impulse venous foot pump (AVI): From Novamedix, A V impulse system & Impad are trademarks of novamedix Distribution limited . It improves the venous flow & the resultant turbulent flow can scour out vein valve pockets a likely area for formation of thrombi. Figure (2) shows a typical venous flow response as measured in the femoral vein showing a clear surge of blood through the entire leg [5].

Assessment of venous blood return

Venous blood flow from the lower extremities is closely related to the peak venous systolic flow (PFV in cm/s) in the femoral vein and to the cross-sectional area (CSA in cm^2) of the vessel, which can be measured by Doppler ultrasound [14] to allow adequate exposure of the femoral vessels during surgery, the right inguinal region was draped to ensure sterile conditions. PFV and CSA were measured with a Doppler ultrasound unit (B&K diagnostic ultrasound system 3535; B&K medical, Norderstedt, Germany) using a 5 MHZ probe (B&K convex array transducer 8544; B&K medical). The Doppler information was converted to a velocity value, and the PFV was shown in cm/s. Figure (3) shows a typical flow measurement during the compression cycle of the AVI device.

PFV and CSA were measured up to seven times: (a)after induction of anesthesia in the supine position (baseline),(b)after initialization of the AVI foot compression device in the supine position (+ AVI group only),(c) 5 min after abdominal insufflation in anti-trendelenburg position, (d)–(f)every 30 min during pneumoperitoneum, (g)after release of abdominal insufflation in the supine position.

Postoperative course and statistics

All patients used compression stockings until discharge. They also received low–molecular heparin {0.6 ml nadroparin (Fraxiparine) from Sanofi Winthrop Paris} (once a day from the day of surgery until one week postoperative).

Standard physical examinations with special attention to clinical signs of thromboembolic complications were done. There was no routine postoperative sonographic or radiologic examination. Statistical analysis of all data and were compared between groups using student's t test.

RESULTS

Sixty patients with a mean age of 42.4 years were randomly assigned to laparoscopic adjustable banding with (+AVI) or without (-AVI). There was no difference in age between the two groups (p= 0.68). Indications for adjustable banding were a body mass index (BMI) above 40Kg/mt2 according to the international indications for bariatric surgery intervention.

All the patients were at risk of thrombosis due to the associated obesity & there was no difference in BMI between the two groups (p= 0.6).

The mean duration of laparoscopy was 67.5 min. Because duration of the surgery varied, intraoperative ultrasound during pneumoperitoneum was performed after 5 min & 30 min in all 60 patients. After 5, 30 and 60 min in 55 patients (+ AVI) group: n = 29; (-AVI) group; n = 26 and after 5, 3, 60 and 90 min in 10 patients (+AVI) group: n = 4; (-AVI) group: n = 6.

The mean PFV in the femoral vein in baseline position was 26.3 cm/s. before pneumoperitoneum, AVI increased the PFV in the (+AVI) group to 37.2 cm/s. five minutes after abdominal insufflation, the PFV dropped in both groups, then it was significantly lower in the (-AVI) group 15.9 cm/s than in the (+AVI) group 26.2 cm/s ($p < 0.01$). PFV remained almost unchanged for the duration of pneumoperitoneum in both groups. After release of insufflation, PFV rose to 37.1 cm/s in the (+AVI) group and 27.5 cm /s in the (-AVI) group $p < 0.01$). PFV decreased to 60% during pneumoperitoneum in the (-AVI) group, whereas PFV remained relatively unchanged in the (+AVI) group $p < 0.05$).

CSA values were similar in both groups in the baseline position (+AVI): 1.03 cm^2, (-AVI): 0.99. ($p = 0.31$). CSA was not significantly altered by AVI before pneumoperitoneum in (+AVI) group. Following abdominal insufflation, CSA rose slightly to 1.18 cm^2 in the (-AVI) group, but it remained almost unchanged in the (+ AVI) group. There was no change in CSA during the further course of the pneumoperitoneum, but the CSA returned to its original size within 5 min after deflation of the abdomen in both groups. CSA increased by 13% during pneumoperitoneum in the (-AVI) group, but it was almost unchanged in the (+ AVI) group ($p<0.01$).

There were no postoperative thromboembolic complications. There was no malfunction of the AVI device and no complications related to the AVI device.

Fig.(1): AV Impulse unit attached to the feet cuff

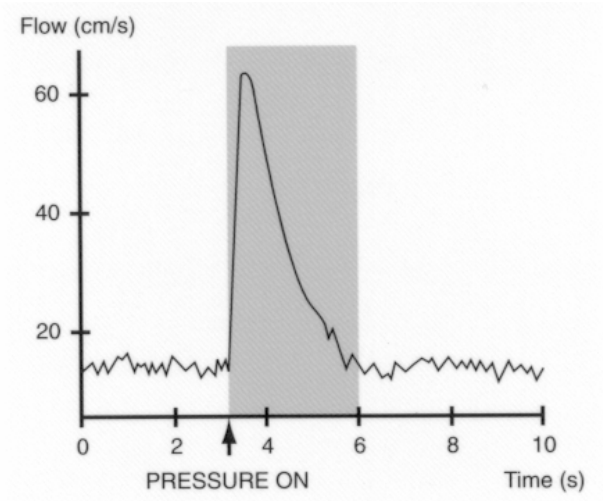

Fig.(2): A Typical venous flow response showing early surge of blood through the entire leg (5).

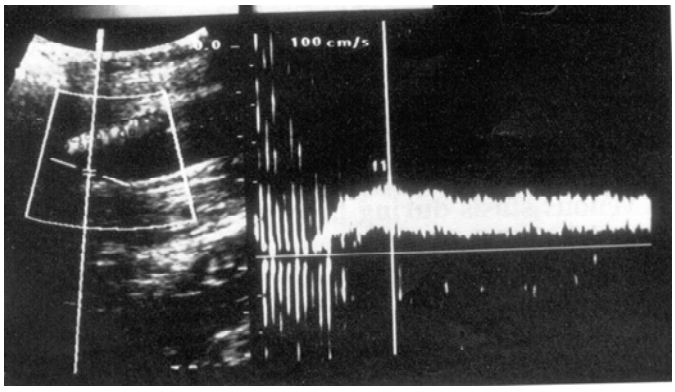

Fig.(3): Sonographic measurement during a compression cycle of AVI.

DISCUSSION

There are numerous conflicting studies on the association between obesity & venous thromboembolism [15]. Although there is a wide range in the reported incidence of thrombosis in morbidly obese patients & no prospective controlled studies, morbid obesity is generally concluded to be a risk factor for the development of perioperative deep vein thrombosis & pulmonary embolism [15]. The rational for prophylaxis of venous thrombosis is based on the clinically silent nature of this phenomenon. Relying on the clinical diagnosis & treatment of the confirmed venous thrombosis may expose susceptible patients to unacceptable risks [4]. Therefore primary prevention is the key to reduce morbidity & mortality from venous thromboembolism [4].

Beside the risk of obesity, laproscopy adds additional risk to develop thombosis due to venous stasis that

accompanies the peumoperitoneum. Hemodynamic response to pneumoperitoneum with CO_2 has been evaluated in experimental and clinical studies [16,17]. It has been shown that the pressure in the vena cava inferior increases with intra-abdominal pressure [2,17] and that venous blood return from the lower extremities is reduced[18]. Goodale *et al*. [19] reported increased femoral vein pressure from 10.2± 4.1mm Hg to 18.2 ± 5.1 mm Hg during abdominal insufflation with CO2 to 14-16 mm Hg and a decrease of venous peak blood flow velocity (PFV) in the femoral vein from 24.9 ± 8.5 cm/s to 18.5 ±4.5 cm/s. Both pressure and PFV returned to baseline values immediately after abdominal deflation.

Ido *et al*. [1] found a decrease in PFV after abdominal insufflation to 5 mm Hg in 16 patients undergoing laparoscopic cholecysectomy. Blood flow velocity decreased even more if abdominal pressure was increased to 10 mm Hg and the patients were placed in the anti-trendelenburg position during insufflation.

To prevent the stasis associated with laparoscopy, the AVI system have been introduced. AVI have been shown to increase mean venous blood flow, peak venous blood flow, and blood volume flow more effectively than single – chamber compression of the calf region only [5-12].

In the present study, PFV decreased by almost 40% during pneumoperitoneum in the (-AVI) group, whereas PFV remained near the baseline level in the (+AVI) group, $p < 0.05$). CSA increased by 20% during pneumoperitoneum in the (-AVI) group, but it was almost unchanged in the (+ AVI) group ($p<0.01$). It was clear that AVI decreased venous stasis significantly similar to other studies in the literature [5,8 &20].

The perioperative utilization of AVI has been shown to prevent thromboembolic complications following conventional abdominal surgery. Fibrinogen scans have shown that external pneumatic compression decreases the incidence of venous thrombosis after major urological [21] and neurosurgical procedures [22]). According to Nicolaides *et al*. [23], perioperative AVI alone prevented deep venous thrombosis almost as effectively as subcutaneous heparin. Borow and Goldson [24] reported a decrease from 26.7% to 11.3% of radiologically diagnosed deep vein thrombosis in patients undergoing longer surgical procedures when a compression device was used. The incidence of postoperative deep vein thrombosis was reduced to 1.5% when a combination of AVI, gradient elastic stockings, and pharmacological therapy was applied in 272 patients after abdominal or orthopedic surgery [25]. Others studied the effect of AVI during laparoscopic cholecystectomy AVI increased PFV by 52- 69% and neutralized the negative effect of pneumoperitoneum on venous blood return from the lower extremities [20].

From our own prospective randomized study and the findings of other authors, we conclude that pneumoperitoneum combined with the anti-trendelenburg position decreases venous blood flow in the femoral vein, thus increasing the risk of venous thrombosis. Obesity adds an additional risk factor for thrombosis. Whether the rate of clinically occult thrombosis is actually increased by laparoscopic surgery is not yet known [3]. However, AVI is a simple, reliable, and inexpensive technique to absolutely neutralize this negative, effect of pneumoperitoneum even during prolonged laparoscopic procedure, especially when the patient is placed in the anti–trendelenburg position & is of high risk of thrombosis due to morbid obesity.

Conclusions:

Venous Prophylaxis is of importance in laparoscopic surgery cases especially in morbidly obese patients. The utilization of the AVI system combined with anticoagulation using low molecular weight heparin could be the optimum method of deep vein thrombosis prophylaxis

REFERENCES

1. Ido K, suzuki T, kimura K, Taniguchi Y, kawamoto C, Isoda N, nagamine N, Ioka T, Kumagai M, Hirayama Y (1995): Lower extremity venous stasis during laparoscopic cholecystectomy as assessed using doppler ultrasound. Surg endosc 9: 310-313

2. Ishizaki Y, Bandai Y, Shimomura K, Abe H, Ohtomo Y, Idezuki Y (1993): Safe intra-abdominal pressure of carbon dioxide pneumoperitoneum during laparoscopic surgery. Surgery 114: 549 –554

3. Jorgensen JO, Lalak NJ, North L, Hanel K, Hunt DR, Morris DL (1994): Venous stasis during laparoscopic cholecystectomy. Surg laparosc endosc 4; 128-133

4. Kalfarentzos F, Stravropoulou F, Karamesini M (2001): Prophylaxis of venous thromboembolism using two different doses of low molecular weight heparin in Bariatric surgery . Journal of Obesity Surgery 11, 671-676

5. Fordyce MJ & Ling SM (1992) : A venous foot pump reduces thrombosis after total hip replacement. J Bone Joint Surg (Br) 74B No 1:45-9.

6. Santori FS, Vitullo A, Stopponi M (1994): Deep vein thrombosis in total hip arthroplasty. J Bone Joint Surg (Br) Vol 76-B No p579-83.

7. Wilson N V, Das k, Kakkar VV (1992): Thrombo-embolic prophylaxis in total knee replacement. J Bone Joint Surg (Br) Vol 74B p50-2.

8. Andrews B, Miller K (1993) : Effect of foot compression on the velocity & volume of blood flow in the deep veins. Br J Surg Vol 80 198-200.

9. Myerson M , Carrol B (1993) : Clinical applications of a pneumatic intermittent impulse compression device after trauma & major surgery to the foot & ankle. Foot and ankle Volume 14 number 4.

10. Morgan M, Magne E (1991) Arterial flow enhancement by impulse compression . Journal of Vascular Surgery, Volume 23 number 3.

11. Warwick DJ, Harrison J , Glew D (1999) : Pneumatic plantar compression versus low molecular weight heparin for the prevention of deep vein thrombosis after total knee replacement. J Bone Joint Surg (Br) Supp II, p210.

12. Warwick DJ, Harrison J & Peters T (1998) : Comparison of the use of foot pump with the use of low molecular weight heparin for the prevention of deep vein thrombosis after total hip replacement . J Bone Joint Surg (Br) Vol 80A No 8.

13. Catona I Mann L , Forsel P (2000) Laparoscopic adjustable gastric banding for obesity. Journal of obesity surgery, 10, 15-21.

14. Moneta Gl, Bedford G, Beac K, Strandness DE (1988) duplex ultrasound assessment of venous diameters, peak velocities, and flow patterns. J Vas Surg 8; 286-291

15. Eugene C, Carlos A, Barba A (2000) : Current practices in the prophylaxis of venous thromboembolism in Bariatric surgery. Journal of Obesity surgery, 10, 7-14.

16. Bannenberg JJG, Rademaker BMP, Gründemann RF, Kalkman CJ, ,meijer DW, Klopper PJ (1995) Hemodynamics during laparoscopy in the supine or prone position. Surg Endosc 9: 125-127

17. Kelman GR, Swapp GH. Smith I, Benzie RJ, Gordon NLM (1972) cardiac output and arterial blood – gas tension during laparoscopy. Br. J Anaesth 44: 1155-1162.

18. Beebe DS, McNevin MP, Crain JM, Letourneau JG, Belani KG, Abrams JA, Goodale RL (1993) Evidence of venous stasis after abdominal insufflation for laparoscopic cholecystectomy. Surg Gynecol obstet 179; 443-447.

19. Goodale Rl, beebe DS, McNevin MP, Boyle M, Leourneau JG, Abrams JH, Cerra F (1993) Hemodynamic, respiratory, and metabolic effects of laparoscopic cholecystectomy. Am J Surg 166: 533-537

20. Schwenk W, Bohm A, Muller M (1998) : Pneumatic compression prevents venous stasis. Surg Endosc 12, 7-11.

21. Hansberry kl, Thompson IM, Bauman J, Deppe S, Rodriguez FR (1991) A prospective comparison of thromboembolic stockings, external sequential pneumatic compression stockings and heparin sodium dihdroergotamine mesylate for the prevention of thromboembolic complications in urological surgery. J urol 145: 1205-1208

22. Skillman JJ. Collins REC, Coe NP, Goldstein BS, Shapiro RM, Zervas NT. Beltmann MA, Salzman EW (1977) Prevention of deep vein thrombosis in neurosurgical patients: a controlled, randomized trial of external pneumatic compression. Surgery 84: 354-358

23. Nicolaides A, Miles G, Hoare M, Jury P, Hemise, Venniker R (1983): Intermittent sequential pneumatic compression of the legs and thromboemoblism stockings in the prevention of postoperative deep venous thrombosis. Surgery 94: 21-25

24. Borow M, Goldson (1981):Postoperative venous thrombosis. Evaluation of five methods of treatment. Am J Surg 141: 245-251.

25. Borow M, Goldson J (1983): Prevention of postoperative deep venous thrombosis and pulmonary emboli with combined modalities. Am Surgeon 49;599-605