Pneumatic positioning and mesh fixation in laparoscopic ventral/incisional hernia repair

New surgical technique and a new device

Ann. Ital. Chir., 2015 86: 279-284
pii: S0003469X1502299X
www.annitalchir.com

Antonio Darecchio*, Paolo Bocchi**, Jan F. Kukleta***

**General Surgeon, Parma, Italy*
***General Surgeon, Surgical Department Director, Val Parma Hospital, Parma, Italy*
****General Surgeon, Zurich, Switzerland*

Pneumatic positioning and mesh fixation in laparoscopic ventral/incisional hernia repair. New surgical technique and a new device

AIM: *To achieve full-surface contact of a prosthetic mesh with the abdominal wall (avoiding folds and wrinkles) in laparoscopic ventral/ incisional hernia repair (LVHR/ LIHR) and to fix the mesh with glue using a new surgical technique and a new device, developed for this specific procedure.*
MATERIAL OF STUDY: *New surgical technique associated with a new surgical pneumatic device allows perfect positioning and extension of the intraperitoneal mesh and facilitates the glue application and mesh fixation. A polyester composite mesh is used for intraperitoneal placement, cyanoacrylate glue is used for mesh fixation. Pigs cadavers were used to test this new technique and the device*.*
RESULTS: *With the help of a pneumatic device the intraperitoneal mesh can be well positioned and perfectly extended without folds, thus allowing an efficient and strong mesh glue fixation.*
CONCLUSION: *Presented pneumatic positioning device is useful to achieve an ideal alignment of mesh with the abdominal wall and supports the fixation task. The proposed technique enables the glue application safely, by avoiding possible spillage over intestinal loops and offering the necessary time for the distribution of such fast polymerizing glue. This technique could also be applied with other types of glue or self-adhesive mesh.*

KEY WORDS: Glue, Mesh fixation, Pneumatic position, Pneumoperitoneum, Ventral/incisional hernia

Introduction

The modern technique of LVHR/LIHR includes high quality mesh with good structural characteristics overlapping the defect by approximately 5 cm. However, the mesh fixation is still the most problematic issue. The transfascial sutures and/ or fixing devices may cause vascular or nerve injury, they may become a cause of a chronic pain and they are involved in formation of adhesions with all their possible consequences (pain syndroms, bowel obstruction, etc.) [1-6]. Main difficulties encountered in intraperitoneal mesh glue fixation are: The retention strength of some biological glues (fibrin glues) is very limited [7]. The necessary glue amount would represent a substantial cost factor.
Cyanoacrylate (successfully used in laparoscopic inguinal hernia repair [8]) is a synthetic glue with great adhesive power, but its polymerization time is very short (becomes hard in a few seconds) and doesn't leave much time for handling.
Some meshes used in abdominal wall hernia repairs can be quite large, resulting in a difficulty to keep the whole mesh surface in contact with the overlying abdominal wall during the act of glue application.

Pervenuto in Redazione Aprile 2014. Accettato per la pubblicazione Gennaio 2015
Correspondence to: Antonio Darecchio, MD, Via Emilia Est 21, 43123 Parma, Italy (e-mail: antonio.darecchio@gmail.com)

Materials and Methods

A new pneumatic device, autonomously developed and conceived by Dr. A. Darecchio, is presented. It is made of a CO_2-chamber in polyethylene double film thermosolder. The chamber is inflated with normal CO_2 pressur used in laparoscopic surgery and a channel can be entered by a surgical endoscope. The main characteristic of the device is that, when inflated, its final shape becomes the same of the abdominal cavity following all the irregularities (Figs. 1, 2, 3, 4). The device substitutes the original pneumoperitoneum with a "neo-pneumoperitoneum", which is bridled in the CO_2 chamber. The surgical procedure was performed on 10 pig cadavers*.

The initial part of this new technique is the same as the current LVHR/LIHR technique: establishing pneumoperitoneum by CO_2 insufflation, 3 trocar introductions in their conventional locations, hernia reduction, adhesiolysis, eventual section of falciform ligament and parietal peritoneal abrasion. The surgeon can draw on the abdominal skin the parietal defect and the perimetral outline of the mesh. The new technique includes drawing two or more concentric rings in the overlap of the mesh in correspondence of the sticking point. Afterwards, trans-parietal Catheters (**C.**), made of Fluorinate Ethylene Propylene (FEP), are inserted under visual endoscopic control in the area of prosthesis overlap. The **C.-FEP** sticking points bring glue drops between the mesh and the parietal peritoneum and ideally substitute the mechanical fixation device. A polyester-collagen mesh is then introduced in the abdominal cavity (Pict. 1). By using 4 temporary trans-parietal sutures, the mesh is centered under the abdominal wall defect. The pneumatic device is inserted from the introductory trocar and put flat on the bowel (Pict. 2-3). The balloon is inflated with the same CO_2 pressure used for the normal pneumoperitoneum (between 10-12 Hg mm). At the same time the original pneumoperitoneum is deflated and the other 2 lateral trocars are removed. Using the endoscope, the surgeon can maintain his visual control of mesh positioning from inside the balloon (Fig. 4). If the mesh is incorrectly located, it is possible to deflate the balloon and repeat the steps described

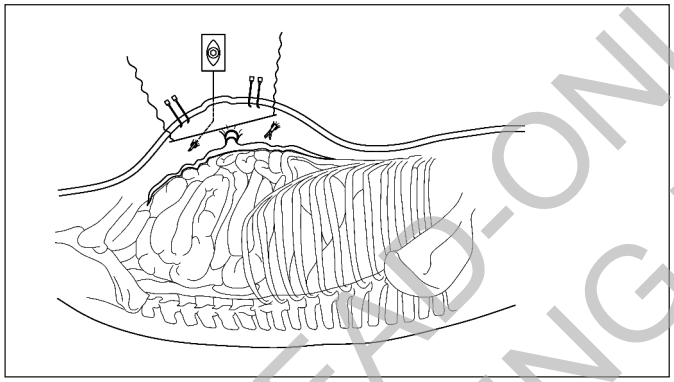


Fig. 1: View before device inflation.

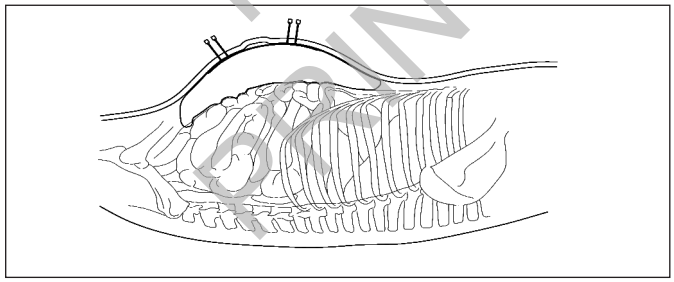


Fig. 2: View after device inflation, (right time for glue injection).

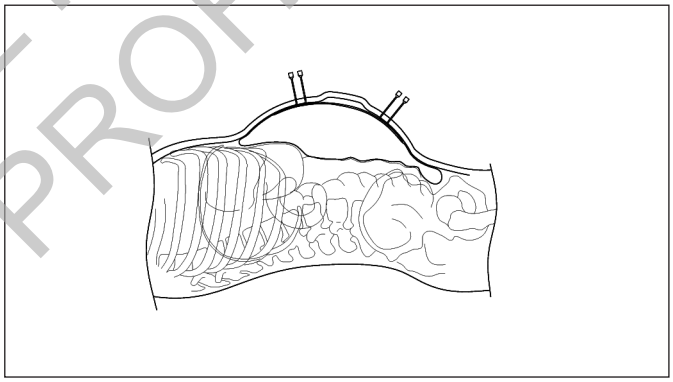


Fig. 3: Lateral view after device inflation, human body (right time for glue injection).

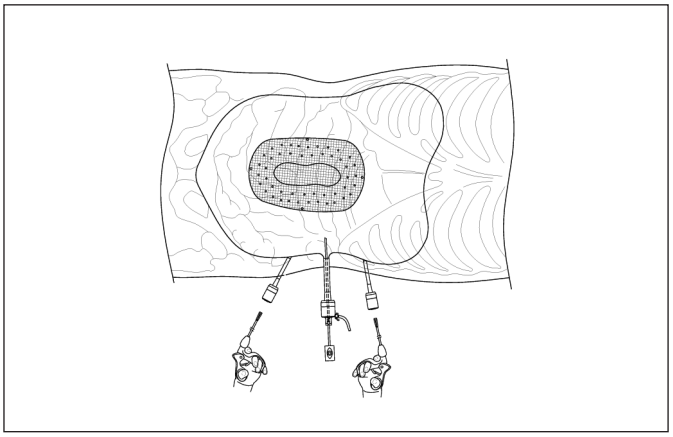


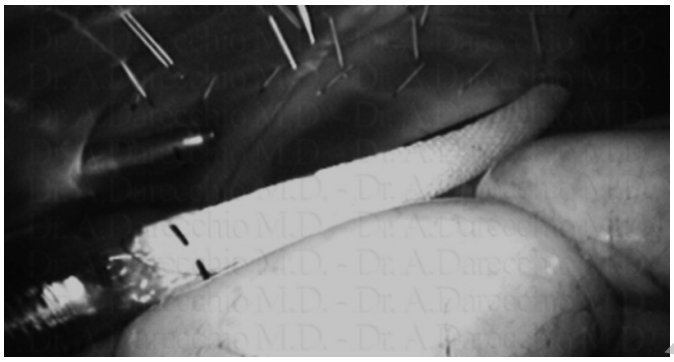
Fig. 4: Frontal view (human body).

* Both the device and surgical technique developments come from research conducted and economically supported by Dr Darecchio. The procedure was tested on 10 swine corpse in accordance with the EC Law 1A69 /2A09.

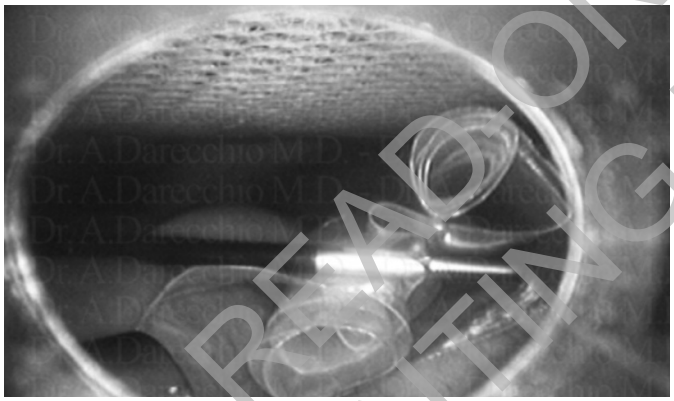
above. When the mesh is correctly positioned the glue drops are injected through the **C-FEP** (Pict. 5). With the endoscope inside of the device, glue drops behavior should be controlled (Pict. 6). Each **C-FEP** should be removed after glue drop injection. The device should be deflated 10 seconds after the last glue drop; the 2 lateral trocars should be repositioned and the original pneumoperitoneum should be reestablished. The deflated balloon is easily removed and extracted from the abdominal cavity (Pict. 8).

Results

In all the performed experimental procedure the mesh is strongly fixed to the abdominal wall, extended without folds and perfectly positioned (Figs 8, 9). Thanks to the presence of the inflated device, the bowel is protected during glue application (Fig. 7). Cyanoacrylate does not stick and react with polyethylene and FEP Catheters. For this reason, the removal of the FEP Catheters and the pneumatic device is easy. The viscer-

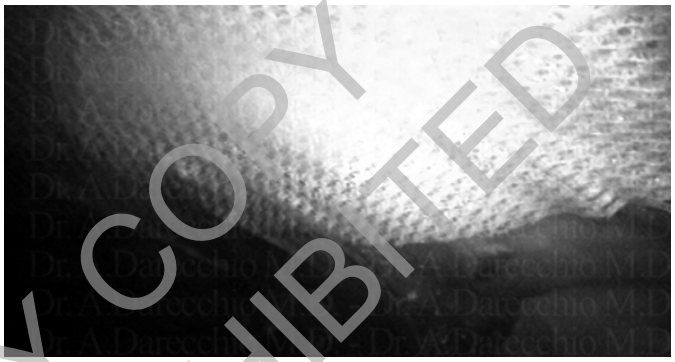


Pict. 1: Mesh introduction and suspension below the sticking points.

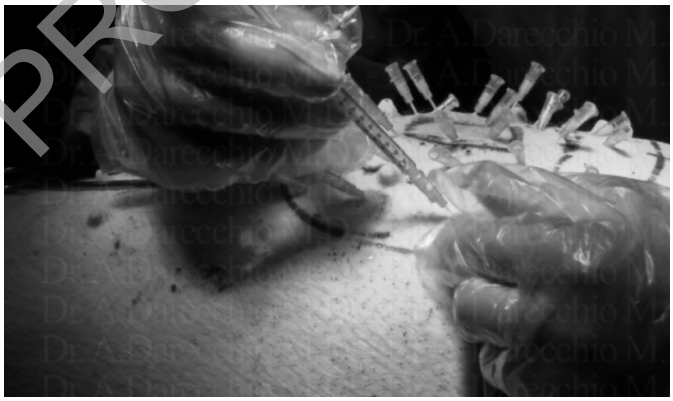


Pict. 2: Device balloon introduction and flat positioning on the bowel.

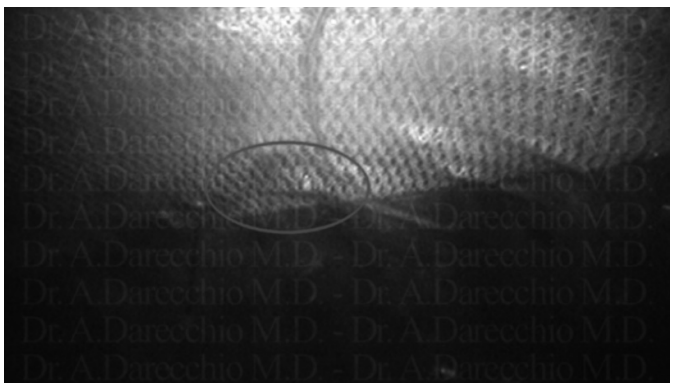
Pict. 3: Sticking points suspended mesh and flat balloon.



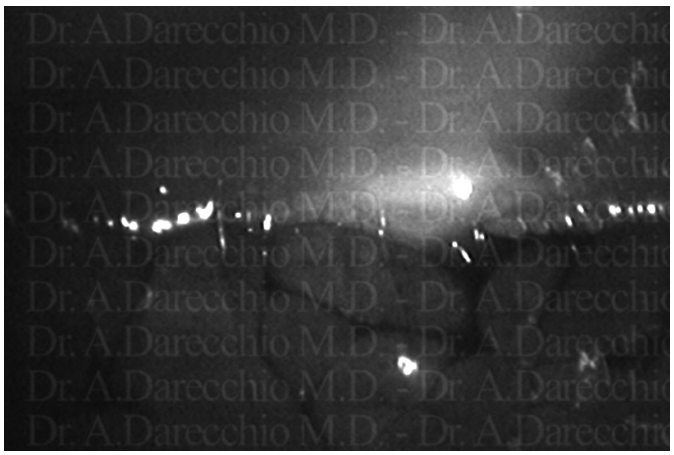
Pict. 4: Control of correct mesh positioning when the device balloon is inflated (the endoscope is inside the balloon).



Pict. 5: Drops of glue injection.



Pict. 6: Glue injection.



Pict. 7: Soft and protective action on the bowel.

Pict. 8: Easy removal of device after sticking.

Pict. 9: Final result: perfectly sticked mesh without folds (external abdominal wall pushing).

al side of the mesh, made of collagen, is protected by the soft action of the pneumatic device.

Discussion and Comments

This technique differs conceptually from current LVHR/LIHR techniques, because the glue application and fixation is the last action after the mesh is perfectly extended and adapted to the overlying abdominal wall thanks to the uniform pressure of the pneumatic device. The technique allows deployment of small drops of an ultra-rapid glue, such as cyanoacrylate, safely and when the mesh is in its final location. It is possible to use just a few drops of glue for each sticking point. The glue substitutes the mechanical fixation device and does not expose the patient to risk associated with the use of such devices.

Conclusion

Next studies are needed to evaluate this technical proposal in order to eliminate the existing problems of mesh positioning and fixation in LVHR/LIHR.

Riassunto

Oggetto di questa pubblicazione è la descrizione di una nuova tecnica chirurgica per la riparazione videolaparoscopica di laparoceli ed ernie della parete addominale anteriore. Tale tecnica è strettamente dipendente dall'utilizzo di un nuovo strumento pneumatico per il posizionamento della protesi. Attualmente esistono in commercio svariati tipi di protesi intraperitoneali con valide caratteristiche strutturali. Tuttavia lo scoglio concettuale rimane sui metodi e sui mezzi di fissaggio delle protesi. I mezzi meccanici di qualsiasi conformazione per il fatto stesso di essere dei mezzi meccanici (spirali metalliche ancorette e viti) espongono al pericolo di danno iatrogeno le strutture vascolari nervose che possono incontrare nel loro percorso. La nuova tecnica proposta mira alla perfetta distensione delle protesi per utilizzo intraperitoneale ed ai loro ottimale fissaggio con adesivo chirurgico in condizioni di sicurezza per le strutture circostanti. Tale tecnica è stata eseguita su cadavere di suino* con protesi intraperitoneali di poliestere-gel-collageno e cyanoacrylate come adesivo chirurgico ma non è esclusa la fattibilità con altri tipi di colle, di protesi, protesi auto-adesive già esistenti in commercio o che potrebbero essere appositamente prodotte.

* Lo sviluppo della tecnica e del dispositivo provengono da ricerca autonoma e autonomamente finanziata dal Dr. Darecchio. I cadaveri di suino sono sati utilizzati rispettando la normativa CE 1A69 /2A09.

References

1. Wassenaar EL, Schoenmaeckers E, Raymakers J, van der Palen J, Rakic S: *Mesh-fixation method and pain and quality of life after laparoscopic ventral or incisional hernia repair: A randomized trial of three fixation techniques.* Surg Endosc, 2010; 24(6):1296-302. doi: 10.1007/s00464-009-0763-1. Epub 2009 Dec 24.

2. Eriksen JR, Poornoroozy P, Jørgensen LN, Jacobsen B, Friis-Andersen HU, Rosenberg J: *Pain, quality of life and recovery after laparoscopic ventral hernia repair*. Hernia, 2009; 13(1):13-21. doi: 10.1007/s10029-008-0414-9. Epub 2008 Aug 1.

3. Gungor B, Malazgirt Z, Topgül K, Gök A, Bilgin M, Yürüker S: *Comparative evaluation of adhesions to intraperitoneally placed fixation materials: A laparoscopic study in rats: adhesions to fixation materials.* Indian J Surg, 2010; 72(6):475-80. doi: 10.1007/s12262-010-0168-3. Epub 2010 Nov 23.

4. Biondi A, Tropea A, Monaco G, Musmeci N, Zanghì G, Basile F: *Complicanze del trattamento laparoscopico delle ernie primitive e secondarie della parete addominale*. Ann Ital Chir, 2010; 81:193-98.

5. Picardi N, Sigismondi G, Di Paolo S, Vene M, Visini R: *Identificazione di un parametro obiettivo di riferimento per la ricostruzione secondo criteri fisiologici del grande laparocele*. Ann Ital Chir 2005; 76(1):31-38.

6. Mazzocchi M, Dessy LA, Sorvillo V, Di Ronza S, Scuderi N: *Study of intraabdominal pressure modification in "component separation" technique for repair of incisional hernia*. Ann Ital Chir, 2010; 81: 433-38.

7. Schug-Pass C, Lippert H, Köckerling F: *Fixation of mesh to the peritoneum using a fibrin glue: Investigations with a biomechanical model and an experimental laparoscopic porcine model.* Surg Endosc, 2009; 23(12):2809-15. doi: 10.1007/s00464-009-0509-0. Epub 2009 May 23.

8. Kukleta JF, Freytag C, Weber M: *Efficiency and safety of mesh fixation in laparoscopic inguinal hernia repair using n-butyl cyanoacrylate: long-term biocompatibility in over 1,300 mesh fixations.* Hernia, 2012; 16(2):153-62. doi: 10.1007/s10029-011-0887-9. Epub 2011 Oct 21.