Videoscopic Plastic Surgery

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Efforts to explore the cavities of the human body date back to Hippocrates,[1] who pioneered "endoscopic" procedures by performing rectoscopy. The following 2400 years brought tremendous technical advances and an understanding of normal and abnormal human anatomy and physiology. In this century, organ transplantation, microsurgery, and most recently fetal surgery[2] have stepped out of the realm of science fiction and into reality.

Concurrent developments in videoscopic surgery continue to evolve at a rapid pace: many operations in general surgery[3,4] and in almost every surgical subspecialty[5,6,7,8] can now be successfully performed videoscopically. Less pain, faster recovery, shorter hospitalization,[9] and less scars are alluring, especially for the patient. Longer operating times, expensive and highly sophisticated new equipment, new skills for the surgeon to learn, and the constant need for well trained assistants are disadvantages of the videoscopic surgical endeavor.

Plastic surgeons must decide whether to embark on videoscopic plastic surgery with innovative enthusiasm or to defer acceptance based on conservative caution or other factors.

This article summarizes the essentials of videoscopic aesthetic, plastic, and reconstructive surgery (referred to as "VAPRES") and reviews current applications and future proposals.

Differences between open and videoscopic surgery

Open and videoscopic surgery are fundamentally different (Table 1).

In the latter the surgical field is accessed via insertion of multiple ports and their strategic placement is required if the operation is performed within a preexisting cavity (abdomen,

Figure 1: Instrumentation, Karl Storz GMBH & Co., Tuttlingen, Germany.

chest). A *small* skin incision is needed if the cavity is to be created surgically. The latter applies to VAPRES in particular, since the vast majority of procedures involve dissection of *tissue planes beneath the skin*. The videoscopic approach is categorized as minimally invasive when compared to the extensive incisions associated with the open approach.

The view of the surgical field changes in a complex manner. The field is displayed on a video monitor, thus three dimensional (stereoscopic) vision is reduced to two dimensions. Since visual perception is created by the brain, training enables the surgeon to overcome the missing third dimension to a large extent. In addition, the image is magnified to the order of 2-10 times. Magnification is associated with the loss of the normal peripheral vision and a reduction of the surgical field. Moreover, the view is controlled by an individual who handles the videoscopic camera. Thus, a *well-trained cameraperson,* who can effectively cooperate with the surgeon is needed. Otherwise the procedure can neither be performed *safely* nor *within a reasonable amount of time*. Alternatively, a single-operator system has recently been developed[10] in which the surgeon's non-dominant hand guides the retractor and endoscope. It eliminates the need for a trained assistant, but forces the surgeon to operate with one hand only.

Figure 2: Phase 1 of the videoscopic training: "Black box" knot tying.

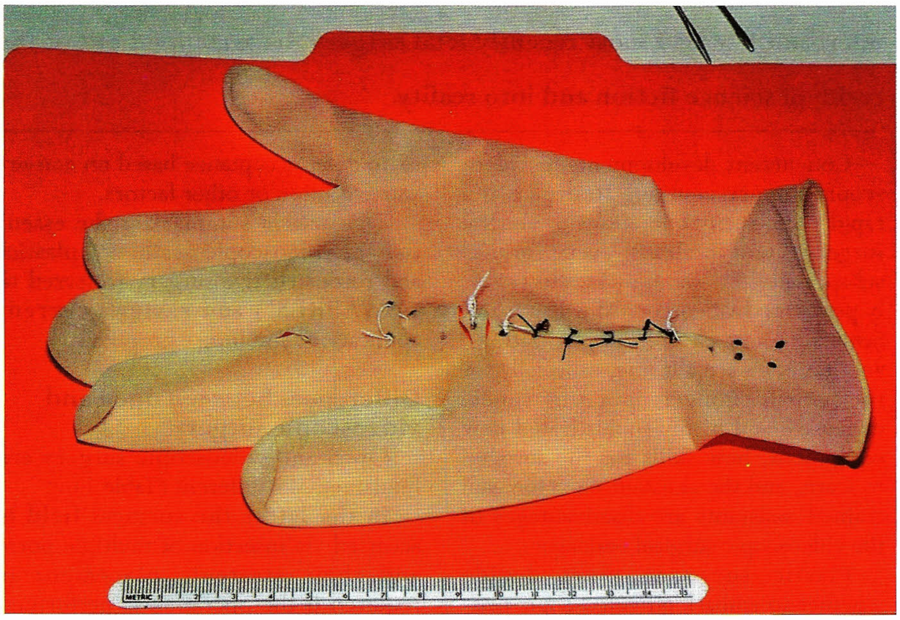

Figure 3: Surgical glove model after a videoscopic training session.

Since videoscopic surgery is performed within a cavity, space is limited. Laparoscopic surgery offers a relatively large space once abdominal insufflation is established; however the working space within surgically created cavities is much more restricted (e.g. in plastic and reconstructive surgery). In open procedures, the surrounding space and the surgical field are visually continuous; in videoscopic surgery, they are visually compartmentalized.

Instruments must be specifically designed to meet the special requirements of videoscopic surgery. They are inserted through a small opening and operated by "remote" action; that is they have a long, thin shaft with the operating part at the tip and the handle at the opposite end of the instrument.

In open surgery, the perceived visual field can be immediately extended to peripheral fields of vision. In contrast, the videoscopic visual field is restricted to the image displayed on the screen. An increase of magnification leads to a decrease of the surgical field. It is, of course, possible to pan the image, however this causes temporary disorientation.

The above-mentioned factors together with magnification influence the working speed. Videoscopic surgery requires *much slower movements* than conventional surgery. The movement pattern is comparable to a tai-chi exercise.

In summary, videoscopic surgery requires modified eye-hand coordination. Meticulous set-up before starting surgery and before each new surgical step is essential. Slow and perfectly controlled as well as highly choreographed movements performed close to the tissue planes are dictated by the narrow surgical field. The limited working range of the instruments, and the missing third dimension add to the challange.

Characteristics of VAPRES

The videoscopic approach may be advantageous when large tissue planes are to be surgically manipulated. The visible scar is reduced to one or two small skin incisions which compares favorably to the long skin incisions to (one or more) if the operation is performed conventionally. The incision site may be distant from the site of dissection (see currant applications). VAPRES provides many other advantages as well (see above).

For most of the VAPRES procedures, the working cavity is created surgically and maintained *mechanically.* The techniques include a small skin incision to identify the proper tissue plane. A surgically created pouch can then be held open by a multifunctional hand retractor. The endoscope and instruments are then introduced. A 10 mm laparoscope is commonly used because it provides the required critical image quality. The

Differences between open and videoscopic surgery

	Open	**Videoscopic**
Access	incision	multiple ports
View	direct stereoscopic scale 1:1 panoramic the surgeon's direct control	indirect (monitor) two-dimensional 2-10x magnification conical the cameraperson's indirect control
Surgical field	surface + open space	cavity + closed space
Instruments	short	stemmed
Working range	unlimited	limited
Working speed	fast	slow
Postoperative recovery	long	short
Cosmetic sequelae	extensive	minimal

Table 1.

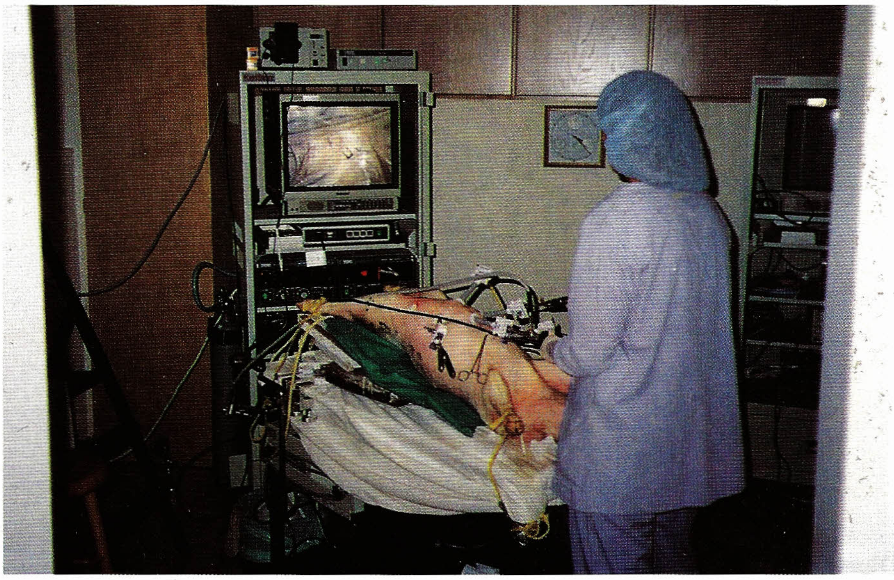

Figure 4: Phase 3 of the videoscopic training: Dissection on anesthetized animal.

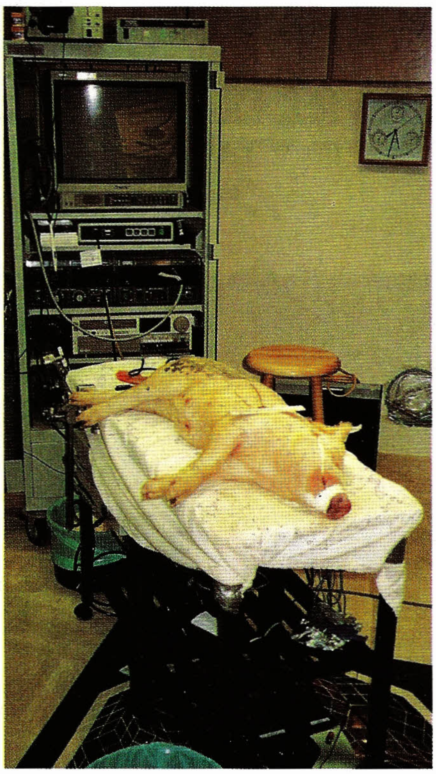

Figure 5: Porcine animal model set-up.

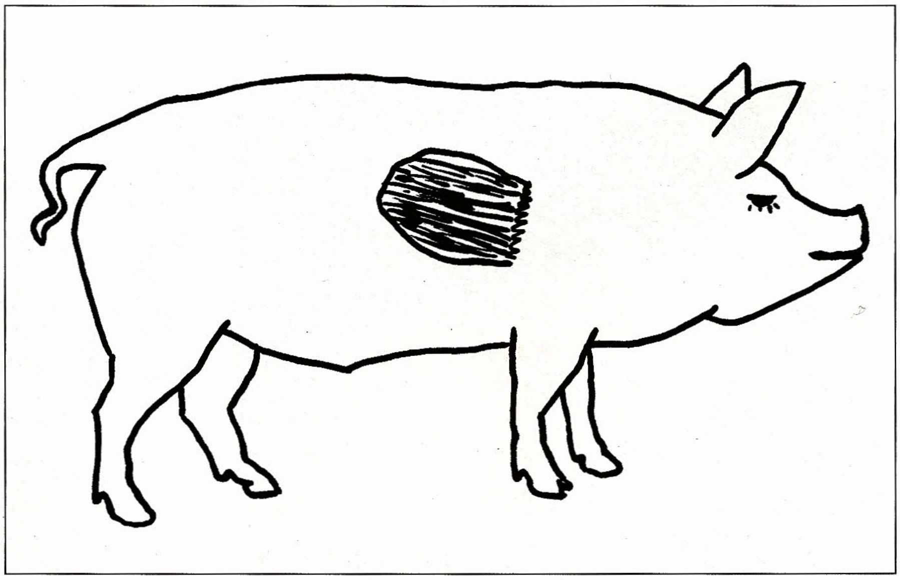

Figure 6: Topographical anatomy of the latissimus dorsi muscle in the pig.

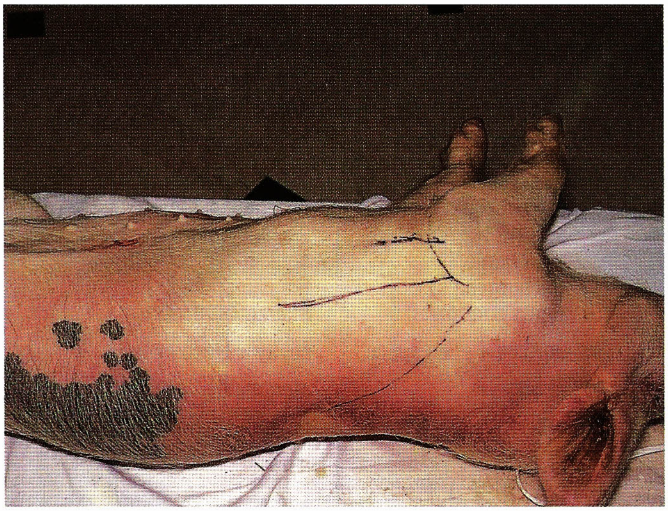

Figure 7: Left latissimus dorsi flap (LDF) marked for open procedure.

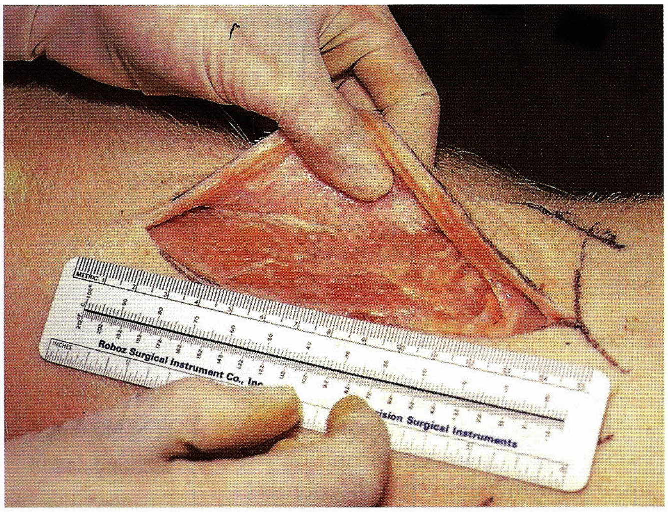

Figure 8: LDF surface partly exposed. Note the length of incision.

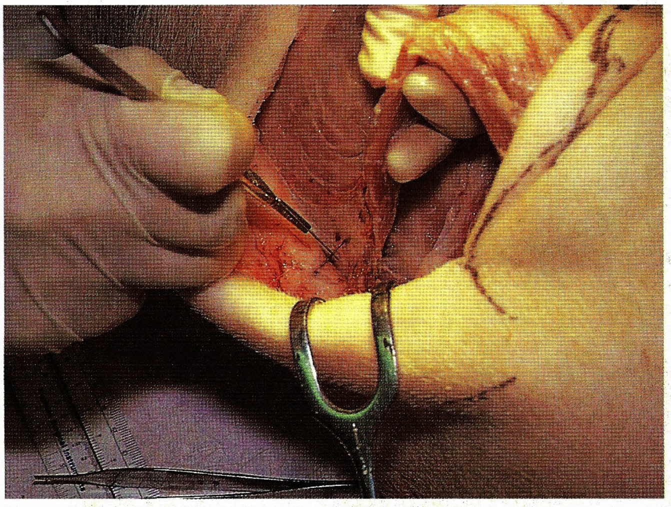

Figure 9: Dissection of the LDF. Skin perforator being transsected.

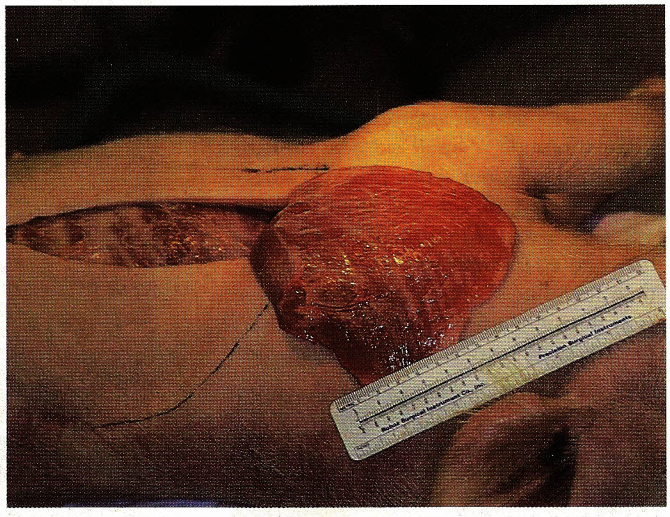

Figure 10: Dissected left LDF exteriorized, open skin incision.

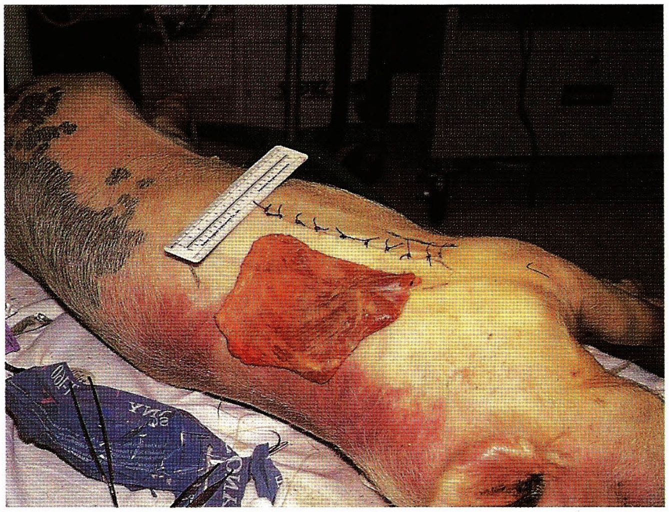

Figure 11: LDF transected, skin incision closed. Note length of the suture.

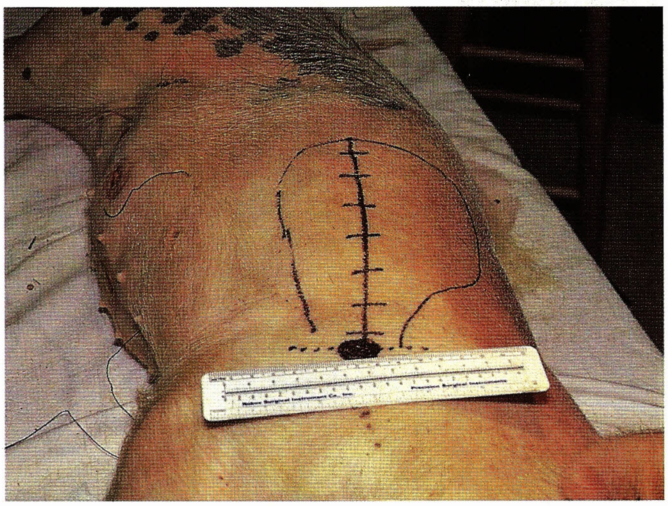

Figure 12: Right latissimus dorsi flap marked for endoscopic procedure.

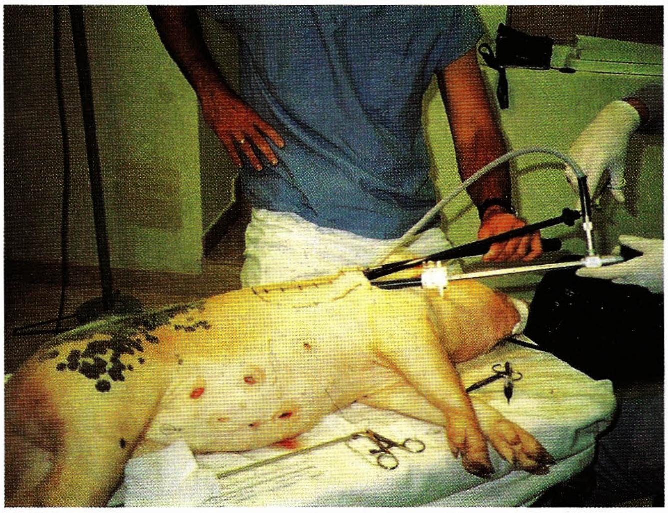

Figure 13: The skin incision is placed, the videosopic instruments introduced.

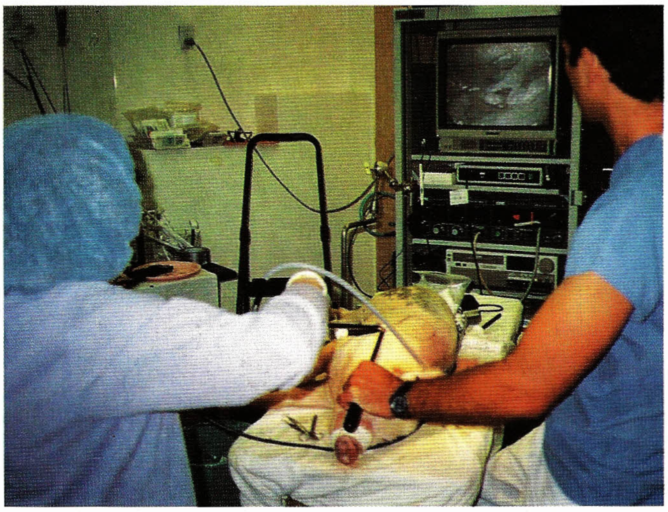

Figure 14: Videoscopic muscle dissection.

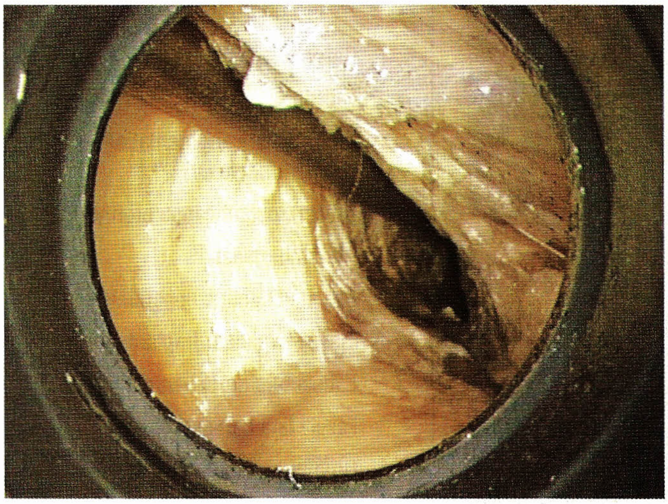

Figure 15: Creation of the working channel (videoscopic view).

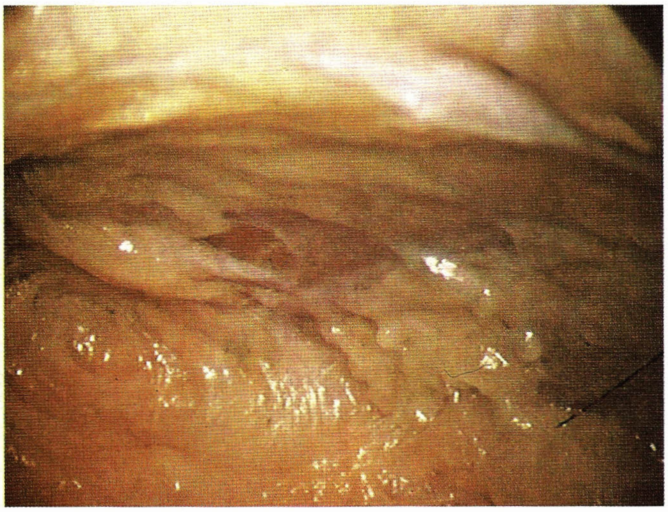

Figure 16: Surface of the LDF (videoscopic view).

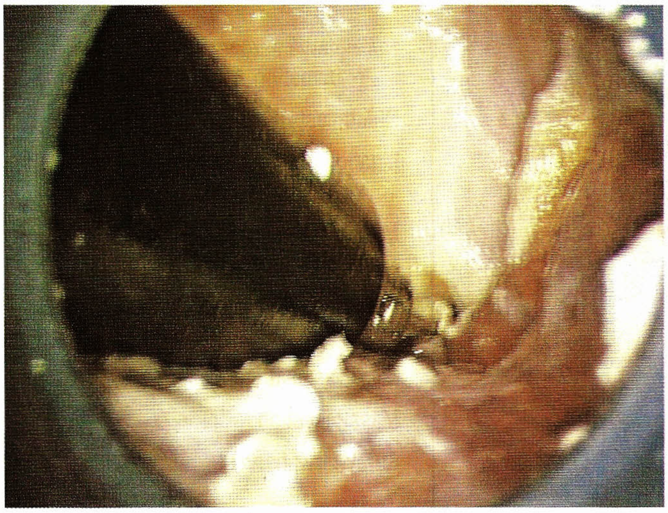

Figure 17: Surgical dissection on top of the muscle with scissors (videoscopic view).

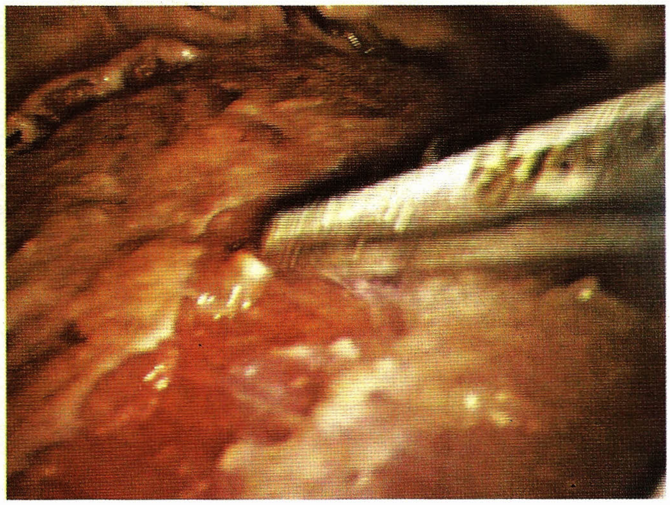

Figure 18: Larger part of the muscle is dissected (videoscopic view).

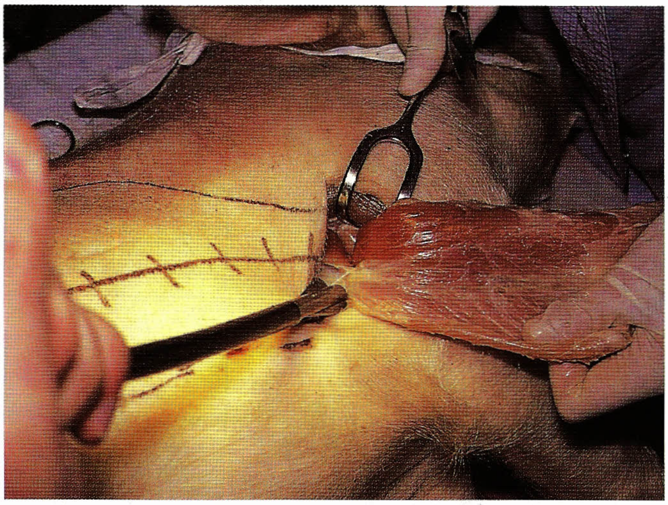

Figure 19: Right latissimus dorsi flap after videoscopic dissection, still pedicled.

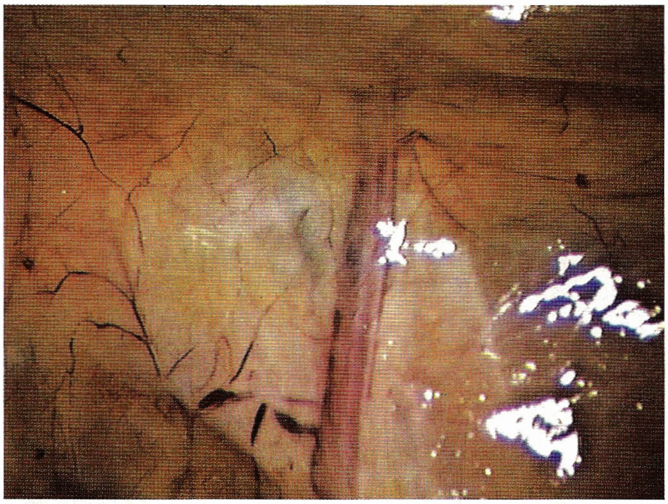

Figure 20: Deep epigastric vessels (laparoscopic view).

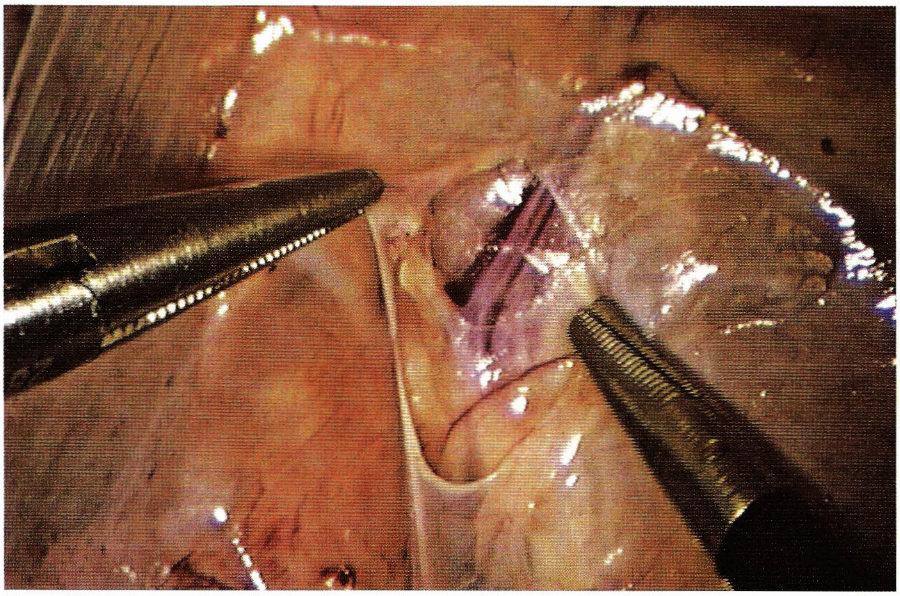

Figure 21: Peritoneum incised, epigastric vessels exposed (laparoscopic view).

CLINICALLY PERFORMED VAPRES PROCEDURES
Coronal face lift[10,17,18]
Facelift [10]
Transaxillary augmentation mammoplasty[10,19,20]
Breast implant capsulotomy[21]
Abdominoplasty[10]
Assisted suction lipectomy[22]
Tissue expander implantation[10]
Latissimus dorsi harvest[10]
Fascia lata harvest[10]
Omentum flap harvest[23]

Table 2.

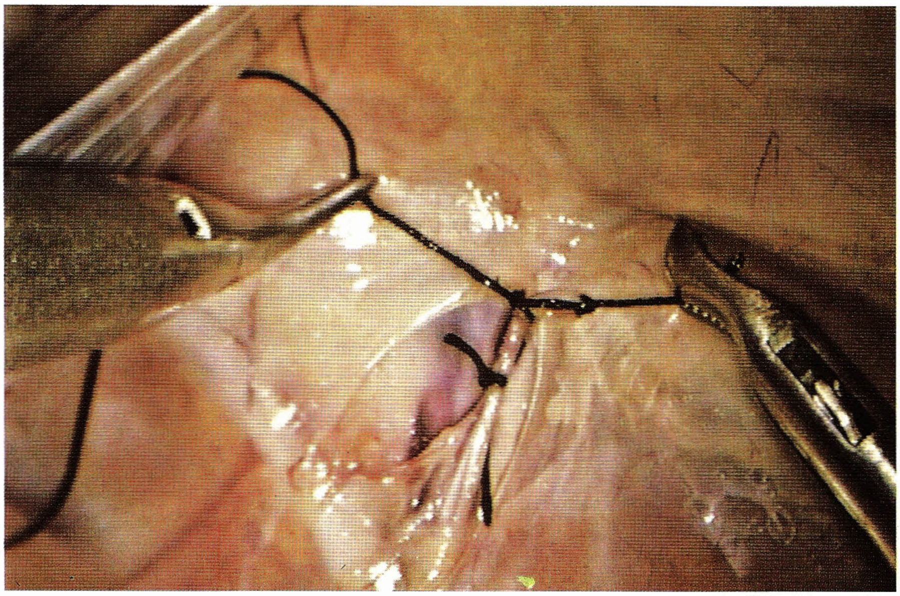

Figure 22: Ligation of the deep epigastric vessels (laparoscopic view).

POSSIBLE FUTURE VAPRES PROCEDURES
Facial nerve surgery, facial reanimation
Rhinoplasty
Ligation of the deep epigastric vessels (pedicled TRAM flap)
Muscle flap harvest: TRAM, tensor fasciae latae, gracilis
First stage of delayed flap harvest (TRAM, latissimus dorsi)
Microvascular angioscopy[24]
Mass resection
Sural nerve harvest

Table 3.

4 mm laparoscope is more appropriate for facial procedures but the image quality is somewhat inferior. From this point, the operation is continued videoscopically. The working cavity grows larger as the operation proceeds, requiring the insertion of progressively larger hooks. Alternatively, specifically designed dissecting balloons can be used. Insufflation of surgically created cavities is possible but may cause excessive CO_2 diffusion into the surrounding soft tissue with emphysema formation and possibly other complications. The technical equipment used in VAPRES, the instrument set-up, blunt and sharp dissection, hemostasis, and knot tying do not differ significantly from other fields of videoscopic surgery. In some situations, the extremely limited working space requires specially modified instruments (Figure 1.) for instance, to cut the insertions of the latissimus dorsi flap, or cautery forceps for smaller bleeders encountered during extensive tissue dissection.

Of note, VAPRES can completely replace certain open procedures such as the coronal face lift or transaxillary augmentation mammoplasty. On the other hand, VAPRES can be a component of a combined procedure, such as the fascial plication in an abdominoplasty,[10] or the flap harvest in a free flap procedure. The videoscopic harvest of the latissimus dorsi flap is illustrated in the porcine training model (Figures 7-19).

Training

Training is key. Since videoscopic surgery represents an entirely new system of surgery, the learning process includes basic knowledge of equipment (camera, various endoscopes and instruments), strategies of camera and instrument set-up, as well as the surgical skills of tissue dissection, clipping, suturing, and knot tying techniques.[11] Insufficient training invariably leads to a higher complication rate,[12,13] frustration to the surgeon and his team. Poor preparation to undertake these procedures may result in a disreputable association with videoscopic surgery. An ideal sequence of training steps begins with a "black box" learning phase (Figures 2-3). After 16 hours the trainee becomes familiar with the basic handling of the equipment and instruments while practicing suturing and knot tying techniques on synthetic materials.[14,15] The next phase (16 hours) encompasses dissection, suturing, and knot tying in non perfused animal tissues. Finally, operations performed in anesthetized animals for another 8 training hours (Figure 4) are indispensable before starting VAPRES in patients. Optimally operations in human cadavers would conclude the training.

We developed a porcine model (Figure 5) to specifically train in VAPRES. The pig was chosen because it is an established videoscopic training model. Its size and anatomy allow the performance most of the current VAPRES procedures. It is easy to anesthetize and cost effective.

A comparison of the open and videoscopic harvest of a latissimus dorsi flap is shown as an example in figures 7-19. The open latissimus dorsi harvest is a common operation[16] and therefore is not described here. For the videoscopic procedure, a 3 cm skin incision is placed at the anterior border of the latissimus dorsi flap and the muscle plane is prepared , creating a pouch. A special retractor, to which the 30 degree laparoscope (Karl Storz GMBH & Co., Tuttlingen, Germany) is attached, is introduced into this pouch. This combines exposure, tissue retraction and visualization all-in-one. Dissection of the upper and lower muscle surfaces and clipping of the vascular branches to the serratus muscle can then be performed videoscopically. When the dissection is completed up to the thoracodorsal pedicle, the latissimus dorsi flap is exteriorized. The pedicle is then dissected under direct vision using standard surgical instruments. As required, the origin of the muscle, the thoracodorsal nerve, and the vascular pedicle can be transected. Analogously, other VAPRES procedures can be performed using this porcine model.

Current applications

Today, VAPRES is not yet common and accordingly the available literature is scant.[10,17-23] However, an increasing number of reports are being presented. Currently, aesthetic indications account for the majority of VAPRES procedures. Except for the latissimus dorsi harvest, fascia lata harvest, and expander implantation,[10] there is little information regarding other reconstructive interventions. The currently performed clinical VAPRES procedures are summarized in Table 2.

The videoscopic technique for coronal and face lift enhances visualization of nerves and muscles and allows "remote" surgery without additional incisions.

This procedure is limited to patients where resection of redundant skin is not necessary. Selective treatment of glabellar frown lines can be achieved by videoscopic resection of the procerus and corrugator muscles.[10] VAPRES assistance in transaxillary augmentation mammoplasty optimizes the creation of the implant pocket. Similarly, transaxillary capsulotomy avoids large submammary incisions. Tissue expander inflation can be started immediately after VAPRES assisted implantation, because the skin incisions are remote from the expander.[10]

Although the videoscopic harvest of the latissimus dorsi significantly reduces the length of the incision and shortens the recovery time, the incidence of seroma formation remains unchanged (Bostwick, personal communication).

Of note, equipment set-up and operative procedures are generally more time consuming than in open procedures.

Future applications

The successful clinical introduction of VAPRES procedures together with an increasing number of videoscopic plastic surgeons will stimulate research activities. The procedures, which are currently being evaluated conceptually or tested in animal models, are summarized in Table 3.

Flap harvest, especially the first stage in delayed flap harvest (Figure 20-22) can potentially be performed videoscopically. TRAM, tensor fascia lata and gracillis muscle flap are potentially suitible for VAPRES because of their topographical characteristics. Another field of interest is facial reanimation. In particular, the midfacial insertion of the transplanted muscle could be more accurately done using videoscopic techniques. Possibly a *one stage* facial reanimation including muscle transplant and nerve coaptation can be realized using a combined videoscopic-microsurgical technique.[25] Benign tumors, which do not involve skin, may in the future be resected videoscopically. This approach is intriguing especially for masses located in areas where the scar from an open resection could cause functional or cosmetical problems, for example the sole of the foot or the face.

Certainly, in the coming years many more procedures will be added to these lists and also eliminate some which will have shown no real benefit from the videoscopic approach. One of the few surgical specialties not yet conquered, is microsurgery. The development of *videoscopic microneurovascularsurgery* represents a major challenge for the plastic surgeon.

ACKNOWLEDGMENTS

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REFERENCES

1.Gunning J.E., and B.A. Rosenzweig: Evolution of endoscopic surgery. Endoscopic Surgery, Mosby-Year Book, St. Louis: R.A. White, S.R. Klein: 3- 9, 1991.
2.Adzick, N.S., and M.R. Harrison: Fetal surgical therapy. Lancet 343: 897- 902,1994.
3. The Southern Surgeons' Club: A prospective analysis of 1518 laparoscopic cholecystectomies. New Engl. J. Med. 324: 1073-1078, 1991.
4.Scott-Conner C.E.H., T.J. Hall, B.L. Anglin, and F.F. Muakkassa: Laparoscopic appendectomy. Ann. Surg. 215: 660-668, 1992.
5.Levine R.L., and H. Reich: Advances in gynecologic laparoscopic procedures. World J.Surg. 17: 63-69, 1993.
6.Estes J.M., Z. Szabo, and M.R. Harrison: Techniques for in utero endoscopic surgery: A new approach for fetal intervention. Surg. Endosc.6: 215-218, 1992.
7.Agee J.M., H.R. McCarroll, R.D. Tortosa, D.A. Berry, R.M. Szabo, and C.A. Peimer: Endoscopic release of the carpal tunnel: a randomized prospective multicenter study. J. Hand Surg. 17 A: 987-995, 1992.
8.El-Guindy A., S. El-Sherief, M. Hagrass, and A. Gamea: Endoscopic endonasal surgery of posterior choanal atresia. J. Laryng. & Otol. 106: 528-529, 1992.
9.Attwood S.E.A., A.D.K. Hill, P.G. Murphy, J. Thornton, and R.B. Stephens: A prospective randomized trial of laparoscopic versus open appendectomy. Surg. 112: 497-501, 1992.
10.Eaves F.F., C.I. Price, J. Bostwick, et al.: Subcutaneous endoscopic plastic surgery using a retractor-mounted system. Persp. Plast. Surg. 7: 1- 27, 1993.
11. Szabo Z.: Endoscopic Suturing and Knotting. Surgical Technology International II. Minimal access surgery. San Francisco: M.H. Braverman and R.L. Tawes (eds.): 123-128, 1993.
12. Reddick E.J.: Avoiding laparoscopic complications. Surgical Technology International II. Minimal access surgery. San Francisco: M.H. Braverman and R.L. Tawes (eds.): 1-4, 1993.
13.See W.A., C.S. Cooper, and R.J. Fisher: Predictors of laparoscopic complications after formal training in laparoscopic surgery. JAMA 270: 2689-2692, 1993.
14.Szabo Z., and G. Berci: Extracorporeal and intracorporeal knotting and suturing techniques. Gastro Endosc Clin North Am 3: 367-379, 1993.
15.Szabo Z., J. Hunter, G. Berci, J. Sackier, and A. Cuscheri: Analysis of surgical movments during suturing in laparoscopy. End. Surg. 2, Georg Thieme Verlag Stuttgart, New York, 1994. p. 1-4.
16.Mathes S.J., and F. Nahai. Clinical atlas of muscle and musculocutaneous flaps. St. Louis: Mosby: 369-391, 1979.
17.Vasconez L.O. et al.: Coronal facelift with endoscopic techniques. Plast. Surg. Forum XV: 227-228, 1992.
18.Isse N.G.: Endoscopic facial rejuvenation: endoforehead, the functional lift. Case reports. Aest. Plast. Surg. 18: 21-29, 1994.
19.Ho L.C.Y.: Endoscopic assisted transaxillary augmentation mammoplasty. Brit. J. Plast. Surg. 46: 332-336, 1993.
20.Johnson G.W., and J.E. Christ: The endoscopic breast augmentation: the transumbilical insertion of saline filled breast implants. Plast. Reconstr. Surg. 92:801-808, 1993.
21.Dowden R.V., and S. Anain: Endoscopic implant evaluation and capsulotomy. Plast. Reconstr. Surg. 91:283-287, 1993.
22.Teimourian B., and S.S. Kroll: Subcutaneous endoscopy in suction lipectomy. Plast. Reconstr. Surg. 74: 708-711, 1984.
23.Saltz R, R. Stowers, M. Smith, and Th.R. Gadacz: Laparoscopically harvested omental free flap to cover a large soft tissue defect. Ann. Surg. 217: 542-547, 1993.
24.Rottler P.D., R. Meystrik, and C.L. Puckett: Microvascular angioscopy. Plast. Reconstr. Surg. 85:397-403, 1990.
25.Koshima I., T. Moriguchi, S. Soeda, et al.: Free rectus femoris muscle transfer for one-stage reconstruction of established facial paralysis. Plast. Reconstr. Surg. 94: 421-430, 1994.