Hernia (1997) 1: 9-14

Hernia

The use of fibrin glues in the surgical treatment of incisional hernias*

J.P. Chevrel[1] and A.M. Rath[2]

[1] Department of General and Gastrointestinal Surgery, Hôpital Avicenne, 125, route de Stalingrad, F-93000 Bobigny, France
[2] Foundation Martine Midy, Department of General and Gastrointestinal Surgery, Hôpital Avicenne, 125, route de Stalingrad, F-93000 Bobigny, France

Summary: The purpose of this work is to report on the results of a series of 110 operations for incisional hernia treated either by primary suture or by a plasty reinforced with a prosthesis placed anterior to the rectus sheath, and fixed by a new method involving a spray of fibrin glue. The composition and properties of the two fibrin glues presently available commercially in France are analysed, together with the procedures undertaken to prevent viral contamination. Several techniques of suture and hernioplasty have been used in this series, prostheses were all placed anterior to the myo-fascial layer. The arguments in favor of the choice of technique are put forward, as well as details of the surgical procedure. There was no mortality in this series. Minor complications were seen in 10% of cases. There was no significant difference between the two types of glue employed. Analysis of the results favors the routine use of suction drainage and a volume of glue of 2 ml. The use of a prosthesis fixed with fibrin glue reduces the definitive recurrence rate to 0.97%, against 9.02% for techniques using a prosthesis only and 18.3% for techniques without a prosthesis, in an overall series of 389 operations.

Key words: Incisional hernia — Fibrin glues — Mesh repair — Prosthesis

* *This work was supported by the Martine Midy Foundation, Paris, France*

Correspondence to: J.P. Chevrel

Received February 2, 1997
Accepted in final form March 25, 1997

Biological or fibrin glues were originally introduced in Austria in 1975. Their safety and effectiveness were responsible for their wide use in many surgical specialties including gastrointestinal, vascular, plastic surgery [Marchac 1994] and, since 1989, in the surgery of the abdominal wall [Bagot d'Arc 1986, Chevrel 1991, Seelich 1988, Sheppard 1993, Wackowlczek 1990].

The aim of this work is to report the results of a series of 110 operations for incisional hernia treated either by primary suture or by a hernioplasty reinforced with a prosthesis placed anterior to the rectus sheath, with the novel introduction of fixation by vaporisation of fibrin glue.

Material and methods

From 1980 to October 1996, 389 patients with 401 incisional hernias have been operated on at the Hôpital Avicenne in Bobigny.

These can be classified as follows:

- 328 midline hernias (84.31%) including 123 supra-umbilical, 65 umbilical, 114 sub-umbilical and 26 xipho-pubic.
- 68 lateral hernias (17.48%) including 31 subcostal hernias, 33 iliac hernias and 4 lumbar.
- 5 parastomal hernias (1.28%) (see Table 1).

The repair of these hernias was sometimes difficult because of anatomical factors. There were 12 multiple hernias in the series, 23 were infected, and particularly difficult were the 153 hernias which had recurred one or more times (36.76%).

Overall, 153 patients received different methods of repair without use of a prosthesis, while 236 were reinforced by means of a prosthesis.

Table 1. Total number of patients: 389. (1980 - October 1996)

Site[a]			
Midline		328	(84.31%)
supra-umbilical	123		
umbilical	65		
infra-umbilical	114		
xipho-pubic	26		
Lateral		68	(17.48%)
sub-costal	31		
iliac s	33		
lumbar	4		
Para-stomal		5	(1.28%)

[a] 12 patients had a double hernia

Table 2. Anatomical site (n = 110)[a]

Midline		101	(91.81%)
supra-umbilical	40		
umbilical	17		
infra-umbilical	34		
xipho-pubic	10		
Lateral		10	(9.09%)
sub-costal	4		
iliac	5		
lumbar	1		

[a] One patient had a double hernia

Table 3.

Without prosthesis n =7		With prosthesis n = 103	
Welti-Eudel	5	Simple suture	27
Clotteau-Prémont	1	Clotteau-Prémont	23
Judd	1	Gibson	10
		Welti-Eudel	15
		Overlaping flaps	20
		Judd	2
		Sandwich	4
		Pro-peritoneal prosth.	1
		Patch	1

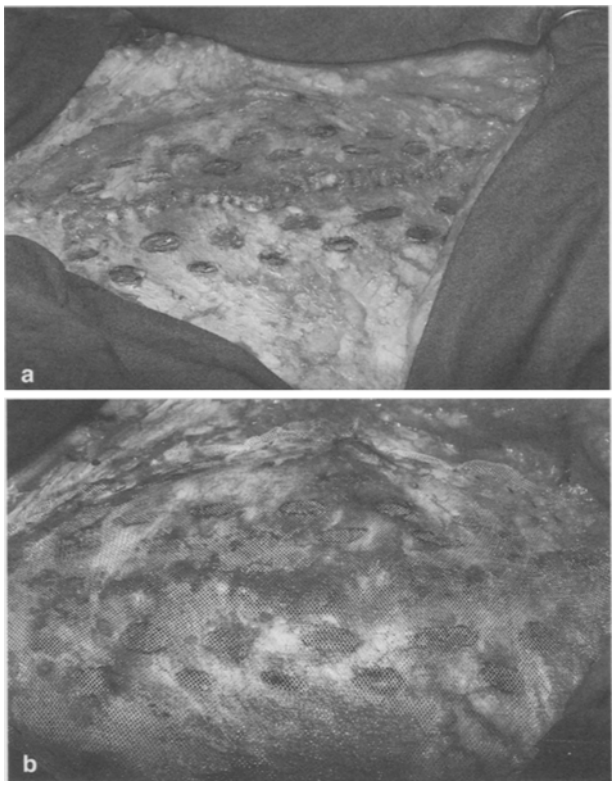

Fig. 1 a, b
a Primary suture with multiple relaxing incision (Clotteau-Prémont's procedure). **b** Reinforcement by a Dacron mesh

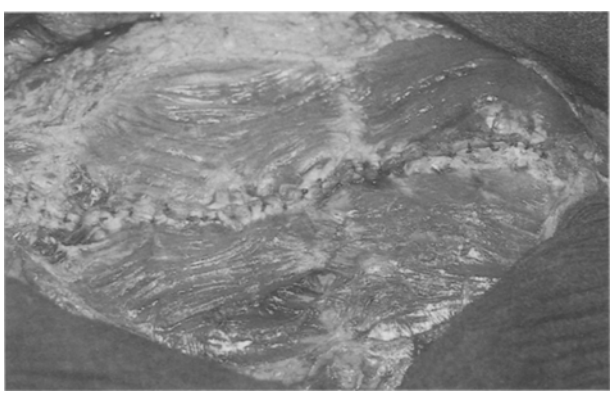

Fig. 2
Plasty with the anterior layer of the rectus sheath (Welti-Eudel's procedure)

We began using fibrin glue in the repair of these hernias in 1989, both in the case of patients who were sutured or repaired without a prosthesis (in order to reduce the extent of subcutaneous dissection during the operation and with the hope of dispensing with drainage) and in those patients with prosthetic reinforcements of the abdominal wall. It is this latter group which forms the object of the present study. It comprises a homogenous series of 110 operations carried out between 1989 and October 1996, 108 of whom have been followed-up (98.18%).

Various techniques of repair by primary suture or plasty have been employed, the choice depending on the site of the hernia, its size, and whether or not it was recurrent. The prostheses were always placed anterior to the rectus sheath.

The present series includes 68 women and 42 men of a mean age of 57.43 years (28/79). The anatomical sites of the incisional hernias are as follows (Table 2):

101 *midline* hernias, divided into 40 supra-umbilical, 17 umbilical, 34 infra-umbilical and 10 xipho-pubic.

10 *lateral* hernias, classified into 4 sub-costal, 5 iliac and 1 lumbar. One patient had a combined xipho-pubic and sub-costal hernia.

The difficult features found in this series included the presence of multiple holes in some incisional hernias (31 out of 110), sepsis (5 out of 110) and particularly the high incidence of multiple recurrences: 54/110.

103 of the patients received a premuscular prosthesis (with the exception of one case of pre-peritoneal placement and one of a patch prosthesis) which on 94 occasions was of non-

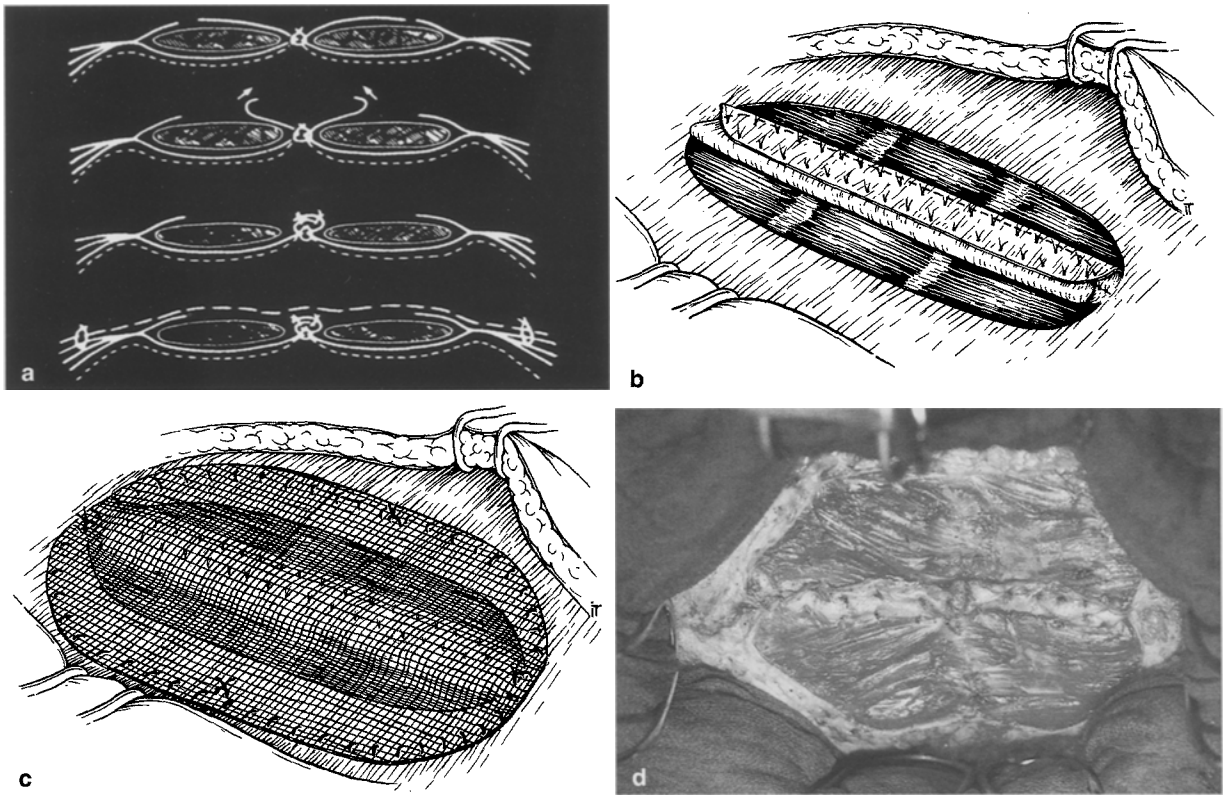

Fig. 3 a-d
a, b Plasty performing an ovelaping flaps covering (Chevrel's procedure). **c** Reinforcement by a prosthesis. **d** Operatory view of the plasty
Fig. 3b,c. From R. Bendavid (1994) In: Prostheses and abdominal wall hernias. Landes, Austin, p 481; used with permission

absorbable material (mersilene or polypropylene) while on 12 occasions the prosthesis was resorbable (polyglactin or polyglycolic acid).

The methods of repair used were as follows (see Table 3):

- simple suture in 24 cases,
- suture with multiple relaxing incision of rectus sheath (Clotteau-Prémont's procedure): 23 cases (Fig. 1 a, b),
- suture with only one large relaxing incision (Gibson's procedure): 10 cases,
- plasty with the anterior layer of the rectus sheath (Welti-Eudel's procedure): 15 cases (Fig. 2),
- plasty with the anterior layer of the rectus sheath performing an overlaping flaps covering (Chevrel's procedure): 20 cases (Fig. 3a, b, c, d),
- Judd's operation: 2 cases,
- sandwich prosthesis placed between two muscular layers over lateral hernia: 4 cases,
- pre-peritoneal prosthesis: 1 case,
- patch prosthesis: 1 case.

We recall the principles of the operation, which include an initial stage of dissection during which it is necessary to resect the peritoneal sac, and to clear and freshen the edges of the defect in order to mobilize the underlying viscera as far as possible in order to be able to reconstruct the abdominal wall without risk to underlying structures. The final dissection phase includes a wide mobilization of the myo-aponeurotic plane extended to the costal margin and down to the iliac crests, and laterally as far as the mid-axillary line.

It is essential to ensure rigorous asepsis, by the use of Betadine soaked swabs, and to carry out meticulous haemostasis, in order to avoid post-operative haematomas.

The stage of repair includes a refashioning of the linea alba, which is almost always possible. In the whole series of 389 patients, only four patients had a significant loss of substance. In three cases this required the use of a patch prosthesis, and in one case a plasty operation by imbrication of the rectus sheath.

This reconstruction of the linea alba is carried out in one layer according to the method of Gibson or Clotteau-Premont, using interrupted sutures of non-absorbable material, or else in two layers according to the method of Welti-Eudel, modified in the form of a overlaping flaps.

We would emphasise the advantage of a overlaping flaps which includes a repair in 4 layers. After making large relaxing incisions on the anterior layer of the rectus sheath, the first layer sutures the edges of the defect. A double aponeurotic layer is then put in in order to construct the overlaping flaps in separate stitches of non-absorbable 2/0 material; finally the fourth layer is represented by the pre-muscular prosthesis.

This non-absorbable prosthesis Dacron (Mersilene™) or Polypropylene (Prolene™) is held in place by four

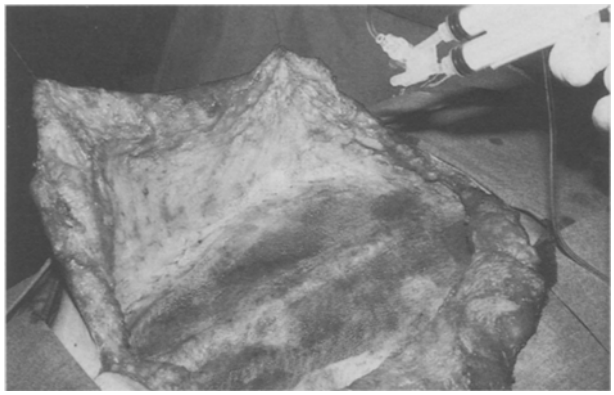

Fig. 4
Spray of fibrin glue at the end of Chevrel's procedure

continuous suture of resorbable 2/0 material, strengthened by paramedian stitches in order to apply the prosthesis correctly on to the muscles and linea alba, which is fixed by spraying on 2 ml of fibrin glue (Fig. 4). In the 110 cases in the series the fibrin glue used was Tissucol in 59 and Biocol in 50. Drainage is ensured by 2-4 suction drains.

The subcutaneous layer is closed with a tight continuous suture of resorbable material and the skin closed with metallic staples.

It is essential, before the patient recovers from anaesthesia, to apply a pressure abdominal bandage and to prevent infection by the injection of 1.0 g of Vancomycin at the beginning of an operation for recurrent cases, and of Cephandol for primary cases. The dressing is not changed until the sixth post-operatively day.

Results

The morbidity was 10.9% (Table 4): six seromas, five of which occurred in patients whose wounds were not drained (2 after Biocol, 4 after Tissucol), three abscesses (two of which occurred in patients who were not drained), two haematomas, one of which occurred in a patient on anticoagulation and one partial skin necrosis.

There was no mortality in this series.

At a longer follow-up we have observed five recurrences (two after simple suture reinforced with a prosthesis, two after the Clotteau-Prémont procedure reinforced with a prosthesis, and one after the Welti-Eudel's procedure with a prosthesis).

Four of these patients were re-operated on with success, there remains one definitive recurrence in 106 patients operated upon (0.95%).

There was no significant difference in the results obtained with either glue, Biocol or Tissucol.

When one compares these results to those obtained on patients operated on previously, it is seen that the present technique is extremely reliable.

In fact for patients operated on without prosthesis, there were 18% recurrences (28/153 cases), for those with a prosthetic reinforcement the overall recurrence is 5.50% but there is a significant difference between those in whom the prosthesis was simply fixed with resorbable sutures, 9.02% and the group where the prosthesis was fixed by spray of collagen glue 0.97% (1/103) (See Table 5 and Figs. 5, 6).

Table 4. Morbidity

Seroma	6	(5.45%)
Abscess	3	(2.72%)
Hematoma	2	(1.81%)
Necrosis	1	(0.90%)

Table 5. Results

Technique	N	Recurrences	%
Without prosthesis	153	28	18.30
With prosthesis	236	13	5.50
without fibrin glue	133	12	9.02
with fibrin glue	103	1	0.97

Table 6. Composition of biological glues. For 1 ml of fibrin glue

	B	T
Lyophilisate 1		
Fibrinogen	127 mg	75/115 mg
Fibronectin	11 mg	2/9 mg
Factor XIII	19 IU	10/50 IU
Lyophilisate 2		
Thrombin	670 IU/ml	500 IU/ml
CaCl2	8 mg	
Reconstitution solution of lyophilisate 1		
Aprotinine	10 000 KIU/ml	3000 KIU/ml
Reconstitution solution of lyophilisate 2		
	Water	CaCl2 40 mmol

KIU: Kallidinogenose inactivation units

Discussion

Fibrin glues

These glues are plasma concentrates which include balanced proportions of fibrinogen, factor XIII and fibronectin. Immediately before use these factors are mixed with a protease inhibitor, aprotinin, which slows down the process of degradation of the fibrin clot, with thrombin, which catalyzes the coagulation process, and with calcium chloride which is equally essential in this process [Burnouf-Radosevich 1988, Seelich 1988].

In this manner the terminal phase of the coagulation cascade is reproduced during the operation, leading to simultaneous haemostasis, scarring and adhesion. The use of these glues is particularly indicated in patients who are heparinized or suffer from a coagulopathy [Tawes 1994].

Table 6 shows the composition of the two fibrin glues, presently available commercially in France: Tissucol (T) (Laboratoire Immuno, France) and Biocol (B) (Laboratoire Français de Fractionnement et Technologie).

The Table 6 demonstrates certain differences in the composition of the two glues. The level of fibrinogin and fibronectin is approximately the same

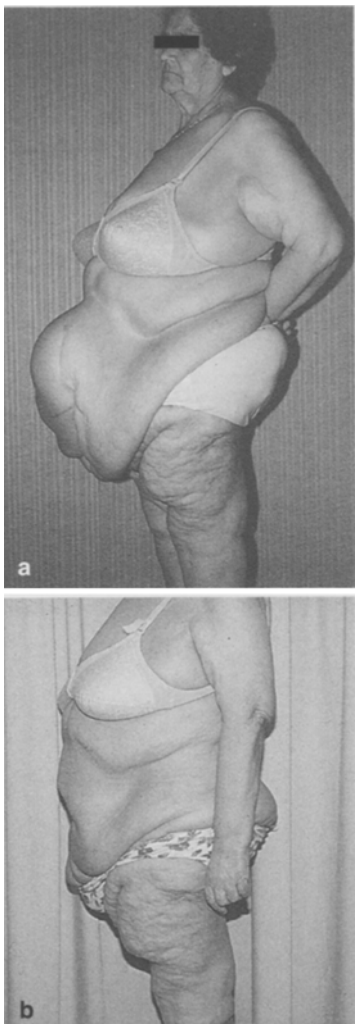

Fig. 5 a, b
a Giant incisional hernia. **b** Result after plasty, prosthesis and fibrin glue

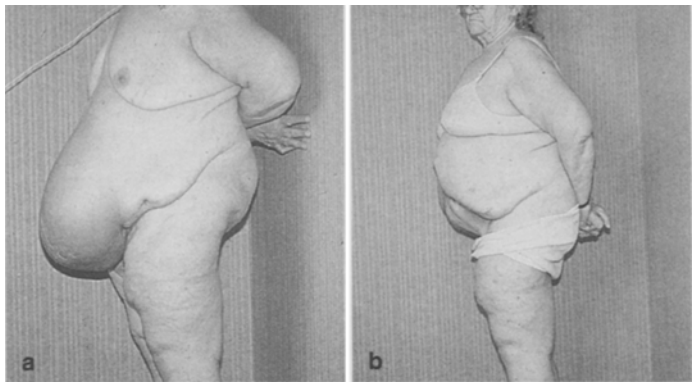

Fig. 6 a, b
a Giant incisional hernia. **b** Result after plasty, prosthesis and fibrin glue

in both products, whereas the content of factor XIII (fibrin stabilising factor) is higher in Tissucol, which regularises the scarring process.

The concentration of thrombin, upon which the speed of adhesion depends, is the same in both products, and ensures adhesion in 20 s. Tissucol also produces a product known as "slow glue" which sets in 1 1/2-2 min, at a level of 4 IU/ml. The concentration of aprotinin is three times higher in Biocol than in Tissucol, which may promote the persistence of fibrin aggregates leading to local inflammatory reactions.

The use of these products is simple. They are presented in the form of two lyophilisates and two solvents. Solution is carried out at 37°C in the case of Tissucol, with the aid of a heat stirrer, and takes some 10 min. The preparation of Biocol is slightly simpler, and takes the same time at room temperature, but the process may be speeded by heating to 37°C.

The two redissolved lyophilisates are each placed in a separate syringe and applied simultaneously by vapourising the products under high pressure gas, with the aid of a double syringe carrier and a spray nozzle.

Prevention of viral contamination

All constituents of both products are derived from human plasma, with the exception of aprotinin, which is of bovine origin.

In order to avoid any risk of viral contamination, the two glues are subjected to rigorous precautions at each stage of their manufacture.

Selection of donors

Biocol is manufactured from plasma derived from French blood transfusion centres, while Tissucol uses plasma coming exclusively from officially licenced plasmaphoresis centres in central Europe. Both products are carefully screened at different stages in their preparation:

Biocol is tested for AgHBs, anti-HBc antibody for Hepatitis B, anti-VHC antibody for Hepatitis C, anti-HIV 1 and 2 antibodies for HIV, anti-HTLV1 and 2 antibodies, ALAT level, serology for syphilis.

Furthermore, during the manufacturing process a specific viral inactivation stage is introduced including:

- a solvent detergent procedure which destroys the envelope of the viruses (HIV, CHV, BVH, CMV & EBP).
- pasteurisation at 60°C for 10 h.
- incubation at 37°C for 22 h at pH 4 in the presence of pepsin which accelerates the process of viral inactivation.

Purification procedures and a check for the absence of viral markers in the finished products complete this battery of precautions. The manufacture of Biocol has received approval from the Institut Pasteur and from the New York Blood Center.

Tissucol. The selection of donors is equally strict. The search for viral contamination uses the same tests (HBs antigen, anti-HBC antibody, anti-HIV antibody, the early P25 antigen, P24 antigen) and, since January 1996, the polymerase chain reaction (PCR) which is a genetic amplification technique allowing, among other things, early screening of the viruses for hepatitis B, C, D, HIV, papilloma virus, herpes and HTLV, particularly during the incubation period. These tests are carried out at the time the

sample is obtained and then repeated on the donor on the 90th day.

During manufacture, viral thermo inactivation (VTI) is carried out by steam heat for 10 h.

A new problem may arise with the recent recognition of the risk of transmission of Bovine Spongiform Encephalopathy (BSE) to man. In fact the aprotinin which is included in the composition of these fibrin glues is of bovine origin. It is at present made in Germany (Hoechst-Behring for Biocol, Bayer and Pentapharm for Tissucol) from bovine lungs originating from countries deemed free of BSE (Argentina, Uruguay).

In the absence of any known case of BSE in these countries the risk seems to be nil. The lungs are considered by the WHO as being only weakly infectious and the methods of obtaining aprotinin are in agreement with the principles laid down by the European Drug Agency. The two laboratories manufacturing aprotinin are at present working simultaneously towards the development of a synthetic product.

Surgical technique

The prostheses were always placed anterior to the rectus sheath for the following reasons:

- Locating the prosthesis in the pre-musculo-fascial position involves extensive tissue mobilisation, which allows one to eliminate lateral traction on the recti exerted through the action of the oblique and transverse muscles. This detachment increases the efficiency of the relaxing incisions, whether they be of the large Gibson type or multiple small incisions as described by Clotteau-Prémont.

- The anterior layer of the rectus sheath should be considered the main tendon of insertion of the oblique muscles into the linea alba.

- The superficial site of the prosthesis allows its tension to be accurately determined at the moment of fixation.

- The biological glue which is sprayed on the prosthesis has an immediate effect on its fixation.

- When a superficial prosthesis becomes infected it can be treated quite simply by local means and does not need to be removed. In contrast, a deeply placed prosthesis may, in the case of any peritoneal dehiscence, find itself once more in contact with hollow viscera, with possible fistula formation.

Others points in technique should be stressed. A drain should always be inserted. In a short series of cases where we dispensed with the drain we had 5 seromas and since then we have always left in place between 2 and 4 suction drains, depending on the extent of the dissection.

With regards to the volume of glue , at the beginning of this series we used 5ml of fibrin glue and it was at this time that we encountered seromas. Despite the fact that we could not demonstrate a causal relationship, we preferred to reduce the volume of glue used and we now use 2 ml, as recommended by the two laboratories which manufacture fibrin glue in Europe.

Fixation with fibrin glue of a prosthesis used in the repair of abdominal hernias brings about a notable improvement in results. This is easily explained by the fact that when the prosthesis is only fixed at its edges by continuous or interrupted sutures, or staples, it does not acquire its full efficacy until it has been invaded by scar tissue, resulting in a virtually new aponeurotic enforcement layer. This requires a delay of 6 to 8 months, as we have shown in a previous experimental study [Rath 1996].

Fibrin glue allows immediate fixation of the prosthesis over its entire surface, giving the effect of an instantaneous repair, and thus avoiding a delay period during which many recurrences occur.

Conclusions

There is no significant difference between Tissucol and Biocol with regards to morbidity or recurrences.

There is a significant correlation between the absence of drainage and morbidity.

There is a significant correlation between the volume of glue applied and the observed morbidity, in that we have seen no complications when not more than 2ml of glue was used.

Overall, there is a significant difference in the recurrence rate of the different groups, namely those without prosthesis versus the group with prosthesis: 8.3% and 5.5% respectively. The rate of recurrence in the prosthetic group without collagen glue versus the group with prosthesis and collagen glue was 9.82 and 0.97%, respectively.

References

Bagot d'Arc M (1986) La colle de fibrine en chirurgie: principe, indications actuelles et perspectives. Cahiers Chir 57: 35-38

Burnouf-Radosevich M, Duval P, Burnouf T, Huart JJ (1988) Composition protéique et qualités des colles biologiques européennes. Lyon Chir 84: 191-195

Chevrel JP (1991a) L'utilisation des colles biologiques dans la cure chirurgicale des éventrations abdominales (Monograph). GREPA, Ethnor, Paris

Chevrel JP (1991b) Utilisation des colles biologiques en pariétologie. 93ème Congrès Fr Chir, Paris

Marchac D, Sandor G (1994) Face lifts and sprayed fibrin glue: an outcome analysis of 200 patients. Br J Plast Surg 47: 306-309

Rath AM, Zhang J, Amouroux J, Chevrel JP (1996) Les prothèses pariétales abdominales: étude bio-mécanique et histologique. Chir 121: 253-265

Seelich Th (1988) À propos des critères de qualité d'une colle biologique. Lyon Chir 84: 259-260

Sheppard BB, De-Virgilio C, Bleiweis M, Milliken JC, Robertson JM (1993) Inhibition of intra-abdominale adhesions: fibrin glue in a long term model. Am Surg 59: 786-790

Tawes RL, Sydorak GR, DuVall TB, Veith J (1994) Autologous fibrin glue: the last step in operative hemostasis. Am J Surg 168: 120-122

Waclawiczek HW, Meiser G (1990) La colle de fibrine en chirurgie : 10 ans d'experience. Lyon Chir 86: 412-417