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Pure Tissue Repair: The Guarnieri's Technique for Inguinal Hernia repair
An analysis of 5700 hernia operations

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ABSTRACT: The Guarnieri's technique for inguinal hernia repair was developed by **Antonio Guarnieri on December 1988**. The basic principle of this technique was to modify the anatomy of the inguinal canal that develops the hernia without modifying the physiology. The technique can be performed either with mesh or without, but the goal of the expert surgeon should be to perform this operation without mesh respecting the physiology of the inguinal canal. Pure tissue repair, this is the aim of this technique. This technique can be considered "tension free" even in cases where the mesh is not used and can be applied in every situation without patient selection. The main characteristics of this method are discussed: use of the mesh, fascial overlapping, relaxing incision, treatment of the transversalis fascia and calibration of the internal ring. We analyzed about 5700 hernia operations performed by different surgeons considering the situations where the mesh was used or not. There were no recurrences in patients operated with mesh, even if the mesh can lead to more complications. The main objective of this method is not only to avoid the recurrence but also to give a comfortable postoperative course.

THE TECHNIQUE

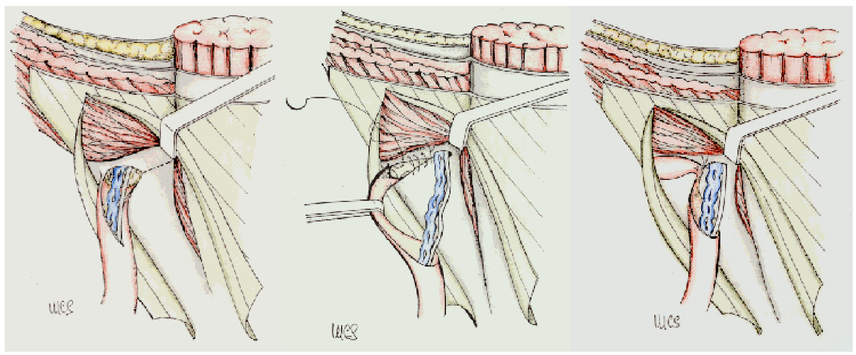

Fig. 1 **Fig. 2** **Fig. 3**

Deep layer: Indirect hernia with a medium-small defect.

An incision on the funiculus involving the proximal tract of the internal spermatic fascia as far as the deep ring, is performed.
The sac, beyond the neck, is isolated. It can be either resected or simply pushed in the preperitoneum. I prefer the second choice, unless the sac is very long and adherent. In this case, I divide it leave the fundus in situ.
The elements of the funiculus (vessels and deferent) are separated from the proximal tract of the internal spermatic fascia and cremaster and then isolated. The isolation is extended to the level of the deep ring and, for a few centimeters, in the preperitoneal area.
A two-centimeter incision is performed on the transversalis fascia and aponeurosis of the transversus, starting on the deep ring, in a medial and cranial direction (Fig. 1).
The elements of the funiculus are brought to the medial angle of this incision (Fig. 2); then, the first layer of suture is started. With the first passage of the thread, a new easily calibrated deep ring is created (Fig. 1). The incision is then sutured until the original ring is completely closed (Fig. 2). Keeping the same suture, a second layer is created, but in the opposite direction, to cover the first layer with the cremaster and internal spermatic fascia. (Fig. 3).

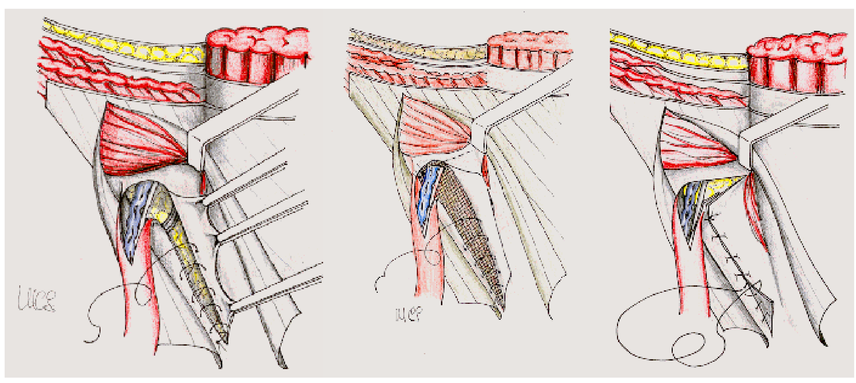

Fig. 4 **Fig. 5** **Fig. 6**

Deep Layer: Direct hernia or indirect hernia with a large defect.

Transformation of the large defect into a small-defect indirect one. The surgery is then completed following the repair technique for a small-defect external oblique hernia.
Having isolated the funiculus and retracted the internal oblique muscle the rest of the operation will follow a precise pattern depending on the nature of the hernia.
In indirect hernia, a medial incision is performed, which involves the proximal tract of the internal spermatic fascia and the deep ring. A second incision on the transversalis fascia of the deep ring up to the pubic spine is performed.
In direct hernia, the transversalis fascia above the hernial sac is resected. Then, an incision on the fascia transversalis is extended cranially, up to the deep ring.
The preperitoneum is detached from the transversalis fascia medially to the hernial defect, beyond the lateral margin of the rectus sheath.
The posterior wall of the inguinal canal is partially closed through overlapping of the flaps with a continuous suture. The suture joins the iliopubic tract to the internal surface of the transversalis fascia at the level of the lateral margin of the rectus muscle (Fig. 4). It starts at the pubic spine and stops at the level of the inferior epigastric vessels. The left-over medial flap of the transversalis fascia is joined, using the same continuous suture, to the iliopubic tract. (Fig.6). The suture does not involve the inguinal ligament and only touches lightly, the deep ring, which is left open.
Then one proceeds as if dealing with a were an indirect hernia with a medium-small defect

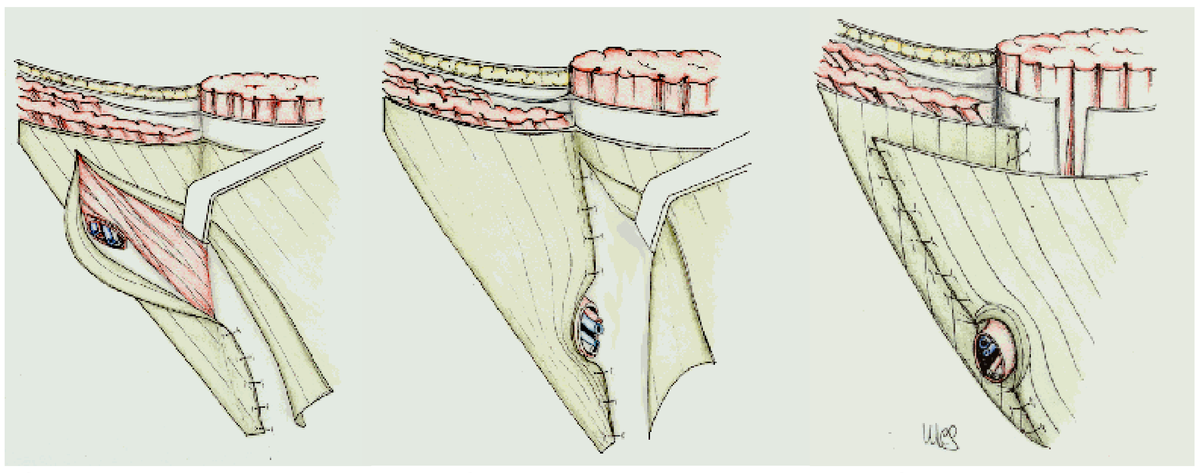

Fig. 7 **Fig. 8** **Fig. 9**

The repair of the superficial layer is the same as in all hernias.

The external side of the inferior-lateral border of the external oblique aponeurosis is freed completely from every adhesion.
The point at which the inferior part of the internal oblique muscle reaches the rectus sheath is found. At this level a new superficial ring is created: the suture is performed between the margin of the inferior-lateral flap of the external oblique aponeurosis and the rectus sheath, along a line parallel and 1 cm medially from the lateral margin of the rectus muscle. The suture runs up to the pubis (Fig. 7), while the funiculus is kept laterally to the operation field. Therefore, the suture is behind the funiculus. Usually, we use continuous suture in both directions, so that it is easier to tie the thread.
The funiculus is relocated in its place, leaning completely on the internal oblique muscle.
Enough space is left for the exit of the funiculus (Fig. 8), and a second suture between the rectus muscle sheath and the lateral margin of the external oblique aponeurosis, along the previous line, is performed. The third suture level is, therefore, completed.
The fourth layer is characterized by the suture which involving the superior-medial flap of the external oblique aponeurosis and the external side of the inferior-lateral aponeurotic flap, so that there is wide overlapping without much tension. This suture level, as the previous one, is ante-funicular and proceeds from the neo- superficial ring to the cranial extreme of the incision and retro-funicular from the superficial neo-orifice to the pubis (Fig. 9).

			Primary Inguinal hernias				
Year	Hernias	Recurrent	External Oblique	Direct	Mixed	Femoral	Abdominal
1988	13	4	6	1	0	0	2
1989	134	8	84	25	7	4	6
1990	212	21	103	46	17	4	21
1991	196	18	112	30	22	2	12
1992	207	14	108	43	13	7	22
1993	243	30	116	45	31	4	17
1994	227	24	111	38	30	3	21
1995	255	19	117	50	41	5	23
1996	347	27	166	69	54	4	27
1997	271	22	110	53	56	5	25
1998	302	20	151	49	48	5	29
1999	323	29	152	60	51	8	23
2000	354	25	166	54	79	4	26
2001	393	17	202	97	41	3	33
2002	421	27	181	75	88	8	42
2003	398	31	170	59	83	3	52
2004	349	27	133	36	112	3	38
2005	300	13	99	25	102	3	58
2006	258	12	84	24	83	3	52
2007	272	17	84	22	89	5	55
2008	233	14	90	21	64	3	41
2009	184	8	56	14	74	4	28
TOTAL	5892	427	2601	936	1185	90	653

Fig. 10: Hernia Operations

USE OF THE MESH (2002-2009)				
	PRIMARY HERNIAS			
Anno	Mesh	No Mesh	%	HERNIA TYPE AND MESH USE
2002	126	218	37%	Indirect Direct Mixed
2003	109	203	35%	27% 21% 49%
2004	121	160	43%	Femoral Recurrent
2005	95	131	42%	100% 100%
2006	44	147	23%	% MESH 2002-2009
2007	41	154	21%	
2008	28	147	16%	
2009	21	123	15%	

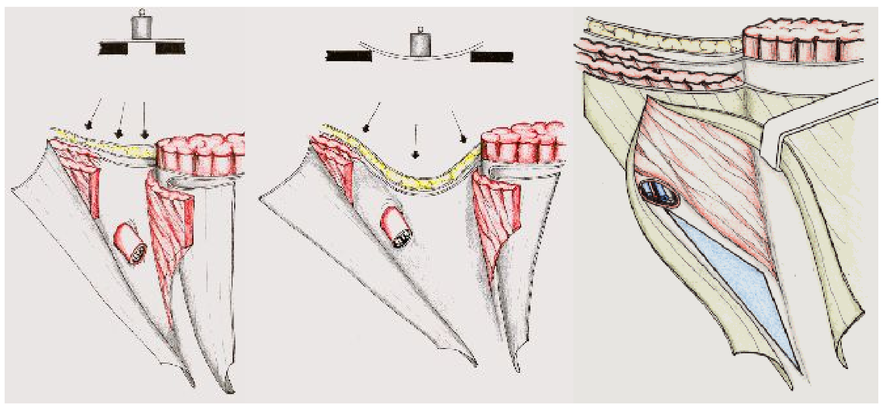

Fig.12: Active and passive areas – The inguinal triangle

Fig. 11 - Mesh Use: mesh is now used in 15 % or our operations. From December 1988 until June 2009 the mesh was used in 23 % of patients.

RELAXING INCISION (2002-2009 ONLY)		
HERNIA TYPE	24%	%
EXTERNAL OBLIQUE		15%
DIRECT		18%
MIXED		36%
MESH		
YES		19%
NO		26%

Fig. 13 USE OF RECTUS MUSCLE RELAXING INCISION

Relaxing incision has always been used from 1988 until 1996. Now, only 24%.

PATIENTS	HERNIA OPERATIONS	AGE MAX	AGE MIN	AGE AVG	M/F	RECURRENCES	% REC
PRIMARY HERNIAS	4812	99	1	54	13:1	27	0,56%
RECURRENT HERNIAS	427	91	34	59	22:1	10	2,34%
ABDOMINAL HERNIAS	653	-	-	-	NR		NR

	ANESTHESIA		
HERNIA TYPE	LOCAL	GENERAI	SPINAL
PRIMARY	75%	15%	10%
RECURRENT	60%	25%	15%

RECURRENCES (1988-2009)			
PRIMARY HERNIAS	**NUMBER**	**RECURRENCES**	**% RECURRENCE**
WITH MESH	1123	0	0,00%
WHITHOUT MESH	3599	27	0,75%
RECURRENT HERNIAS			
WITH MESH	427	10	2,34%
FEMORAL HERNIAS			
WITH MESH	90	0	0,00%

HOSPIDALIZATION DAYS (2008 ONLY)		
MIN	MAX	AVG
0	15	1,39

	POSTOPERATIVE COMPLICATIONS			
COMPLICATION	PRIMARY HERNIA		RECURRENT HERNIA	
Subcutaneous Seroma	288	6,00%	59	14,00%
Temporary Testicular Edema	4	0,10%	8	2,00%
Hematomas	19	0,40%	8	2,00%
Wound Infections	4	0,10%	3	0,80%
Testicular Atrophy	9	0,20%	6	1,50%
PATIENTS	4812		427	

Year	10 YEARS FOLLOW_UP INGUINAL RECURRENT AND FEMORAL HERNIAS											
1988	11	11	11	11	11	11	11	11	11	11	11	11
1989	128	128	128	128	128	128	128	128	128	128	128	128
1990	191	191	191	191	191	191	191	191	191	191	191	191
1991	184	184	184	184	184	184	184	184	184	184	184	184
1992	185	185	185	185	185	185	185	185	185	185	185	185
1993	226	226	226	226	226	226	226	226	226	226	226	226
1994	206	206	206	206	206	206	206	206	206	206	206	206
1995	232	232	232	232	232	232	232	232	232	232	232	232
1996	320	320	320	320	320	320	320	320	320	320	320	320
1997	246	246	246	246	246	246	246	246	246	246	246	246
1998	273	273	273	273	273	273	273	273	273	273	273	273
1999	300	300	300	300	300	300	300	300	300	300	300	2202
2000	328	328	328	328	328	328	328	328	328	328	2502	273
2001	360	360	360	360	360	360	360	360	360	2830	573	174
2002	379	379	379	379	379	379	379	379	3190	901	368	63,74%
2003	346	346	346	346	346	346	346	3569	1261	587	64,22%	
2004	311	311	311	311	311	311	3915	1640	871	65,15%		
2005	242	242	242	242	242	4226	1986	1145	69,07%			
2006	206	206	206	206	4468	2297	1483	69,82%				
2007	217	217	217	4674	2539	1727	74,67%					
2008	192	192	4891	2745	1933	75,19%						
2009	156	5083	2962	2145	76,13%							
	5239	3154	2356	78,14%								
10 YEARS	3310	2834	79,54%									
EFFECTIVE	3283	89,85%										
RATE	99,18%											
Year	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998

YEAR	RECURRENT HERNIAS	HIGH	LOW	MIXED	M	F
1998	20	10	5	5	20	0
1999	29	15	8	6	28	1
2000	25	14	4	7	25	0
2001	17	12	1	4	14	3
2002	27	17	2	8	26	1
2003	31	13	6	12	29	2
2004	27	14	6	7	26	1
2005	13	5	2	6	13	0
2006	12	4	1	7	12	0
2007	17	7	3	7	17	1
2008	14	7	3	4	12	2
2009	8	5	1	2	8	0
	240	123	42	75	230	11
		51,25%	17,50%	31,25%	95,83%	4,58%

TABLE A: Localization of recurrent inguinal hernia: Most of recurrences are located at the level of the internal ring and are in the higher portion of the inguinal triangle. This also happens when previous operation is performed with a mesh. Mixed recurrent hernias are often found. It is uncommon to find a single direct or femoral recurrent hernia located in the lover portion of the inguinal triangle.

Tables: our series of patients

Guarnieri
casa di cura accreditata

CONSIDERATIONS

SUTURE TENSION: The rectus muscle and the transversalis fascia are very flexible. Besides, the already moderate amount of suture tension existing is reduced by sutures above. Furthermore, it involves the tract between the lower epigastric vessels and the pubis where there is less distance between the edge of the muscle and the iliopubic tract (Fig.6). It is also important to consider the difference between suture tension under rest and under stress. In the posterior wall the inguinal triangle is a passive area that works differently under stress and under rest (Fig.12). According to the Laplace law a cylindrical baloon blown up tends to dilate more where the radius is greater even if the pressure applied is the same (Fig. 12).
We must consider that many recurrences are in the higher portion of the inguinal canal (Table A).
The external oblique aponeurosis is transversally very elastic. The sutures are executed in such a way as to avoid excessive traction and stress due to muscular contraction. The external oblique muscle contracts longitudinally and not transversally with respect to the suture line. Scarring is not impeded by the moderate tension of the suture, also because the aponeurosis receives a scarce blood flow and is, therefore, not subject to ischemia. The risk of iatrogenic crural hernia is minimal even in techniques like Shouldice's, which perform direct sutures along the whole inguinal ligament. In our technique only the most superficial part of the inguinal ligament is barely involved and in no way subjected to transversal traction. I can also say that since 1990 we began exploring the crural ring, We have never encountered crural pseudo-recurrences in our patients, while We have come across subclinical crural hernias in 2.2 % during primary hernia operations.
USE OF MESH: In primary hernias if the tissues are very weak, inelastic and lacking in quantity we use meshes to reinforce the hernioplasty. This now occurs in 15% primary hernia cases (average 23 % since December 1988) . The mesh is positioned in the preperitoneum or alternately in front of the posterior wall of the inguinal canal and of the deep ring, once it has been closed (small meshes in few cases). Mesh may also be used for prudential reasons when the surgeon is not very familiar with the physiological hernioplasty technique. The mesh is used more frequently for multiple hernia defects (Fig. 11). We always use mesh in crural hernias and in recurrence. In this case, we try to close (successfully in most cases) or, in any case, to narrow the hernial defect as far as possible. In crural and recurrent hernias meshes are always used and positioned in the preperitoneum. The mesh use could lead to more complications (seromas, neuralgias and testicular atrophy). This should be further investigated. No recurrence was detected in patients operated for primary hernia with mesh. The mesh use has been reduced since 2002, because operator's experienxce (Fig.11). Antonio Guarnieri, author of our technique, stopped its activities in 2002, leaving a percentage of personal use of mesh of 6%. His successors now used the mesh in 15% of cases for reducing the recurrence rate.
FASCIAL OVERLAPPING: The external oblique aponeurosis is elastic and pliable along the fibers' transversal axis. By suturing the external aponeurotic flap to the rectus sheath, a narrowing of the inguinal canal and of the inguinal triangle characterized by a moderate degree of suture traction, is produced. The medial flap is brought to overlap the lateral one abundantly, producing a minimum amount of tension. This overlaying distributes the already moderate suture traction even more and creates an extensive and compact scar area, which prevents the external oblique aponeurosis from fraying. Consequently, this aponeurotic layer, as a veritable biological prosthesis, creates new compact scar tissue which reinforces the passive areas without tension of the sutures.
The greatest advantage is obtained at inguinal triangle level (Fig.12), a passive area where traditional methods frequently encounter recurrence. In the inguinal triangle, the lateral flap of the external oblique aponeurosis, without the intrusion of the funiculus, is placed directly on top of the transversalis fascia, with which it forms an adherent cicatricial plane. The medial flap of the aponeurosis is overlapped once more forming a second plane. Together, these create a strong wall, certainly no less strong that one produced by a mesh.
CALIBRATION OF THE DEEP RING: In most cases the deep ring is surrounded by weak tissues, unable to resist suture strain. Its reconstruction usually proves quite untrustworthy. For this reason almost all herniorrhaphy techniques seek to reinforce the deep ring, and anchor it to the inguinal ligament, thus, immobilizing and stiffening and defunctionalizing it.
Besides, the deep ring is not clearly detectable unless the cremaster is cut. The tissue weakness, together with defunctionalization and approximate suture, are among the chief causes of recurrence.
For this reason, we have chosen to create a neo-deep ring, which may be easily calibrated around the funicular elements, and positioned in a stronger zone where it can be protected by the internal oblique muscle. When the transversus muscle contracts, the neo-ring narrows and rises, because it is situated between the fibers of the aponeurotic arch. The sphincter effect is thus repaired (Fig.1-3).
RELAXING INCISION: As to narrowing of the posterior inguinal canal wall, until February 1996, we supported the idea of the rectus sheath relaxing incision and performed it systematically. We held that this relaxing incision served to expand the rectus muscle laterally and narrow the inguinal canal. We were not interested in reducing the suture tension between the external oblique aponeurosis and the rectus sheath, which we considered minimal. After systematic examinations availing of ultrasound and CAT scans we discovered that lateral expansion of the rectus muscle did not in fact occur. We therefore have reduced the relaxing incision to 24 % of patients with primary hernia (Fig.13), which choice produced no changes in either postoperative conditions or results. At the same time we paid greater attention to the question of freeing the lateral flap of the external oblique aponeurosis from the lateral fascial tissues to bring it closer to the rectus muscle (Fig. 9).

CONCLUTIONS

Mesh can be avoided in most cases. Good results can be obtained with a "pure tissue repair" method like the one that we are performing in our institution. The role of rectus sheath relaxing incision and mesh indications should be further evaluated. Our technique improves the concept of "tension free hernioplasty" with the notion of active and passive areas and the Laplace law. The surgical experience remains the most important factor to obtain the best performance.