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ORIGINAL ARTICLE

Laparoscopic myomectomy using endoscopic loops under progressive tension

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Abstract The Authors describe a novel technique for laparoscopic myomectomy of fibroids with a subserosal component which involves the use of endoscopic loops under progressive tension to avoid bleeding, facilitate enucleation and possibly reduce the need of conventional sutures. Data analysis from a series of 34 consecutive operations shows that the use of endoloops helps achieving a good haemostasis, and no case of haemorrhage from the fibroid bed was ever recorded. Moreover, the need of diathermy was reduced, and the enucleation of the fibroids resulted facilitated by a bloodless field and the squeezing effect induced by the progressive tension on the loops. Although a reduction of number of traditional suturing was recorded, we do not recommend this technique to surgeons who are not familiar with conventional laparoscopic suturing. Overall, the suggested use of endoscopic loops seems to facilitate laparoscopic myomectomy on fibroids with at least a partial subserosal component. We believe that this method deserves comparative studies in order to furtherly demonstrate its safety and efficacy.

Keywords Laparoscopy · Myomectomy · Uterine fibroids · Surgical techniques · Endoscopic loops · Conservative treatment

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Introduction

Laparoscopic myomectomy was first performed by Semm and Mettler in the late 1970s [1]. Since the early 1990s, the surgical technique has been furtherly developed and studied [2, 3] mainly because of proven advantages of laparoscopy such as postoperative pain and recovery [4] and minor scarring. Nevertheless, laparoscopic myomectomy is generally acknowledged as a difficult and time-consuming procedure that certainly requires solid laparoscopic skills, and the European Society of Gynaecological Endoscopy includes it among the advanced level procedures [5]. On the other hand, large studies exist to demonstrate its safety and efficacy [6].

We wish to describe a technique for laparoscopic myomectomy of fibroids with at least a subserosal component which involves the use of endoscopic loops under progressive tension and demonstrate its feasibility through the analysis of a series of 34 consecutive operations performed at the "Policlinico A. Gemelli", academic hospital of the Catholic University of the Sacred Heart, Rome, Italy.

Surgical technique

This novel technique is based on the use of pre-formed, disposable endoscopic loops (SURGITIE™ 0, 3.5 met/dec, AutoSuture, US Surgical Corporation) that are commonly used as suture and haemostasis tools in various gynaecological endoscopy interventions, such as adnexectomy or salpingectomy.

These loops are assembled with a 3.9 mm nylon cannula which serves as knot pusher. The thread of the loop is a reabsorbable polyfilament (POLYSORB™), which is

53 cm long and has a USP. (US Pharmacopeia) size of "0". The diameter of the loop measures 12 cm.

A relevant property of such endoscopic loops, one that we find very useful in case of laparoscopic myomectomy, is the possibility of being progressively tied, so that the tension on tissues is gradually increased. In order to achieve that, the suture *tail* is not immediately trimmed and the integrated knot pusher is kept attached to it and repeatedly used during the intervention.

Our interventions are commonly performed with a 10 mm trans-umbilical trocar for the laparoscope and three ancillary suprapubic trocars (one on each side, and a third on the mid-line). One of the lateral trocars is substituted by a 10–12 mm one once morcellation is performed. The choice of the port through which the endoloop will be used varies depending on the position of the fibroid. In any case, when the tension on the myometrium is accurate, the nylon cannula/knot-pusher integrated is pulled outside the abdomen, while still connected to the thread. By doing so, we avoid loosing one of the suprapubic accesses, since 5 mm trocars easily allow the simultaneous passage of the loop's tail and another laparoscopic instrument, such as Manhes graspers, scissors or a bipolar grasper.

Once the pneumoperitoneum is established and all the ports are in place, we begin the intervention. The surgical strategy can vary depending on the type of fibroid we are dealing with.

Fibroids which are mainly subserosal or pedunculated with a large stalk are characterised by an acute angle between themselves and the uterine wall (Fig. 1a). That constitutes a comfortable groove where the loop is easily applied and tension applied. We then proceed with an incision on the serosa overlying the fibroid with a monopolar electrode which goes as deep as the myomatous fibres are exposed. Right after the first incision, there is a possibility of bleeding, which is commoner when a thicker healthy tissue overlies the fibroid, but a simple and progressive tension applied to the loop by pushing gently its knot is able to control haemorrhage.

On the contrary, fibroids which are mainly intramural might not offer the same acute angle with the healthy tissue (Fig. 1b). In these cases, we begin with an incision over the tumour. Once the fibroid is reached and exposed, it is grasped and pulled, so that it is tractioned towards the uterine surface and virtually converted into a subserosal one. Once this is achieved, the loop can be applied as previously described and the intervention continues by following a common pathway.

Fibroids are carefully and progressively enucleated by following the avascular cleavage plane between the pseudocapsule, which is constituted by compressed healthy tissue, and the tumour node. The endoloop is progressively tied, offering two important advantages: the first consists in mechanically reducing bleeding from perimyomatous vessels; the second is a better exposition of the cleavage plane thanks to the "squeezing" action exerted by the loop (Fig. 2).

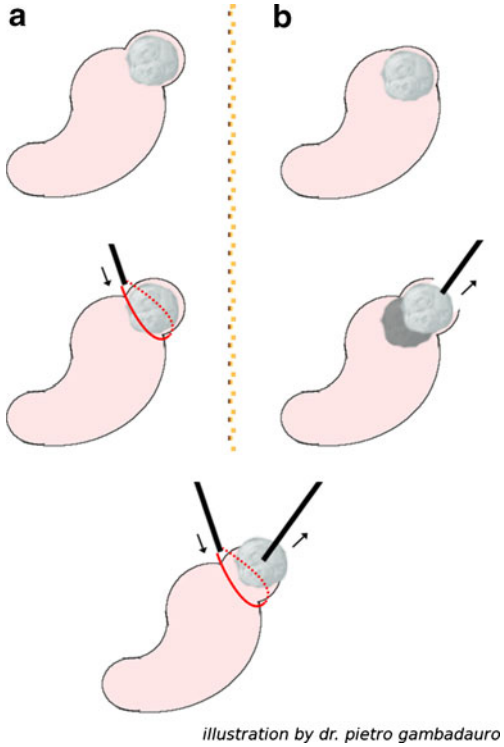

Fig. 1 Use of endoscopic loops during laparoscopic myomectomy for fibroids with at least a subserosal component. The technique depends on the volume of the intramural component. **a** Fibroids which are mainly subserosal or pedunculated with a large stalk are characterised by an acute angle between themselves and the uterine wall. That constitutes a comfortable groove where the loop is easily applied and tension exerted. The serosa overlying the fibroid is then incised with a monopolar electrode until the myomatous fibres are exposed. **b** Fibroids which are mainly intramural might not offer the same acute angle with the healthy tissue. We begin with an incision over the tumour. Once the fibroid is reached, it is grasped and tractioned towards the uterine surface so that it is virtually converted into a subserosal one. The loop can now be applied, and the intervention continues by following a common pathway. Illustrations by Dr. Pietro Gambadauro

Enucleation must always be carried out while minimising any damage to healthy myometrium, which is usually rich of blood vessels, frequently distorted and dilated because of the fibroid growth. One of our aims is to minimise the use of diathermy and subsequent risk of necrosis on the healthy tissue, which is meant to heal with a good scar. We find that, while using the endoloops, the use of diathermy is sensibly reduced and limited to haemostasis on few vascularised myometrial bridges, which sometimes are particularly adherent to the tumour and hardly spared also by the most careful blunt dissection.

Once the fibroid has been totally enucleated, the loop's knot is once more pushed and its thread trimmed. When

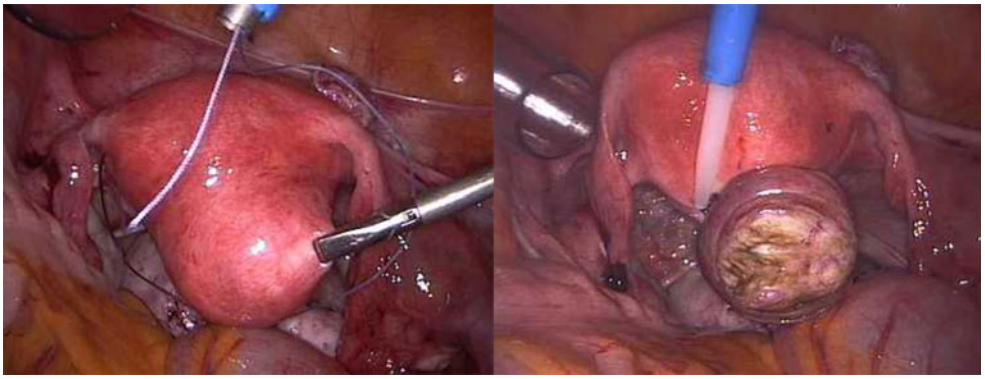

Fig. 2 The endoloop is progressively tied during the fibroid enucleation, thus offering two important advantages: the first consists in mechanically reducing bleeding from perimyomatous vessels; the second is a better exposition of the cleavage plane thanks to the "squeezing" action exerted by the loop

complete haemostasy or satisfactory tissue approximation is not achieved, superficial bipolar coagulation or interrupted polyglactin sutures tied with intra- or extra-corporeal knots are used.

Fibroids are always extracted via a Steiner electrical morcellator. The abdominal aponeurotic sheath is sutured only in case of incisions ≥10 mm. Cutaneous incisions are sutured with simple stitches with rapidly reabsorbable material.

Case series

We have collected and analysed the data from a series of 34 patients who underwent laparoscopic myomectomy with endoloops under progressive tension under our care. Patients' mean age was 35.7±5 (range, 24–51) and indications to surgery included pelvic pain and pressure, abnormal uterine bleeding and unexplained infertility.

Overall number of enucleated fibroids was 46 (1.3 fibroids/patient), with a mean diameter of 61.32±25 mm (range, 20–100 mm). Fibroids characteristics were as follows: 12 (26%) subserosal with >50% volume intramural; 26 (57%) subserosal with <50% volume intramural; six (13%) pedunculated with a broad stalk; two (4%) infraligamentary.

The cases were divided into four categories, according to the previously described fibroid characteristics. In case of multiple fibroids, the case was categorised according to the characteristic of the fibroid with the largest intramural part (Table 1).

For each category, we have analysed operative time, need of traditional sutures, postoperative hospital stay, conversions to laparotomy, and complications such as haemorrhage or infections. Moreover, we have analysed the need of additional sutures for each operated fibroid.

Mean operative time (±SD) was 100.15±42 min (range, 40–240 min.). Interventions where we removed at least a fibroid with a >50% intramural component where longer than the rest (119.22±62.92 min versus 92.47±30.47 min; mean ± SD), although this difference is not significative, probably because of the small sample size. As we expected, the shortest interventions were those where only pedunculated fibroids with a broad stalk (79.4±24.54 min; mean ± SD) (Table 1).

Table 1 Results of laparoscopic myomectomy with endoscopic loops under progressive tension depending on fibroid type

	Subserosal/Intramural[a]		Pedunculated with a broad stalk	Infraligamentary
	>50% intramural	<50% intramural		
Number of cases	11	17	5	1
Fibroids/patient[b]	1.4±0.51	1.5±0.51	1±0	1
Largest fibroid[b], mm	54.09±27.09	63.23±22.00	74±26.07	50
Operative time[b], min	119.22±62.92	95.88±32.98	79.4±24.54	100
Traditional suture (cases)	4 (36.36%)	2 (11.76%)	0	0
Hospital stay[b], days	2.2±1.75	1.7±0.8	2±1.73	1
Complications[c]	1	1	0	0
Hemorrhage from fibroid bed	0	0	0	0

In case of multiple fibroids, the characteristic of the fibroid with the largest intramural part were taken into account

[a] According to the presence/absence of at least one fibroid with an intramural component >50%

[b] Values are mean ± standard deviation

[c] See text

Overall, intraoperative blood loss was always estimated ≤400 ml, except for two patients who suffered haemorrhagic complications, though not related to the myomectomy site. A patient developed an abdominal wall haematoma from a suprapubic port site and another had an entry-related bleeding lesion on the sacrum promontorium, which was repaired with a laparoscopic suture. In both cases, interventions were totally laparoscopic and no blood transfusions were needed, although those were the only patients in the series who developed postoperative anaemia.

A conversion to laparotomy was performed in a patient right after the complete enucleation of a subserosal fibroid with the loop technique because of suspected multiple intramural fibroids.

Traditional laparoscopic sutures were needed in six interventions (17.6%). Surgical time of interventions where additional suturing was needed was longer (159±54.81 versus 89.64±30.02 min for interventions without additional sutures). At a *t* test, the difference resulted significative (p=0.0001), also once the two complicated cases and the laparotomy were excluded by the analysis (138.75± 35.67 versus 90.17±23.24; p=0.0004).

Such sutures were needed in the 33.33% of subserosal fibroids with a >50% intramural component, while only in the 15.3% of those <50% intramural (Table 2). The mean diameter of fibroids needing suture was 4.62 cm for mainly intramural ones, while it was 6.5 cm for the mainly subserosal ones. Pedunculated and infraligamentary fibroids did not need any additional suturing other than the endoloop.

Mean postoperative stay (±SD) was 1.9±1 days with no differences between different categories.

Only a patient underwent a second-look, during a laparoscopic Gametes Intra-Fallopian Transfer (GIFT). In this case, no adhesions were observed and the scar looked well healed.

Discussion

Excessive bleeding probably represents the most feared complication of myomectomy, both in laparotomy and laparoscopy, and the attempts of reducing that risk have influenced the evolution of the surgical technique of fibroid removal.

During the first half of the last century, myomectomy pioneering surgeons were challenged by the bleeding issue and some tried to contribute to the solution of this problem.

For instance, Bonney [7] developed a specific clamp to apply on uterine vessels, while Rubin [8] described a technique based on the use of a catheter tied as a tourniquet around the isthmus through two holes on the broad ligament bilaterally.

More recently, various strategies have been proposed to reduce bleeding during myomectomy [9]. Various authors have advocated a pre-treatment with GnRH analogues in order to induce amenorrhea and improve haemoglobin values in anaemic patients, as well as to reduce fibroids volume [10] and vascularization [11]. In facts, Vercellini et al. demonstrated that a GnRH-a pre-treatment does not reduce blood loss during laparotomic myomectomies [12]. For laparoscopic myomectomies, the experience of our group [13] leads us to use GnRH analogues only in case of pre-operatory anaemia, since we have not found any surgical benefit in such a treatment, which on the contrary seems to increase the difficulty of the enucleation of the fibroid because of a loss of the cleavage plane [14].

Vasoconstrictors such as vasopressin have also been advocated, via intramyometrial injection, but serious complications have been reported with their use [15].

Some authors have also described surgical techniques for a temporary mechanical interruption of uterine blood flow during laparoscopic myomectomy that recall the methods adopted by myomectomy pioneers.

In 1997, Ostrzenski [16] proposed a temporary compression of uterine vessels at isthmic level using a No. 0-Polydioxanone (PDS) Endoknot suture.

In more recent years, the group of Adam Magos, from London, has been actively studying the use of single and triple tourniquets to reduce blood loss during myomectomy both in laparotomy and in laparoscopy, with promising results [17, 18].

Our technique, which in contrast to the previous does not apply to intramural fibroids which are deeply embedded in the myometrium, also follows that rather old concept of temporarily interrupting the blood supply in order to limit haemorrhage. The peculiarity is that endoscopic loops only

Table 2 Need of conventional laparoscopic sutures depending on fibroid type

	Conventional suture	Suture/fibroids (%)	Mean fibroid diameter
Subserosal >50% intramural	4/12	33.33	4.62 cm
Subserosal <50% intramural	4/26	15.3	6.5 cm
Pedunculated with broad stalk	0/6	0	–
Infraligamentary	0/2	0	–
TOT	8/46	17.39	5.56 cm

exclude from the circulation the fibroid area, thus avoiding global ischaemia of the uterus.

Moreover, the use of loops under progressive tension may also facilitate fibroid enucleation, not only because of the virtually bloodless field, but also thanks to the cited squeezing effect that helps the exposure of the cleavage plane and progressively pushes the tumours outside the myometrial context, which is very useful for fibroids with a greater intramural component. This allows to spare healthy myometrium and to avoid distended and dilated perimyomatous vessels [19], which represent a potential source of bleeding.

In our case series, we have not recorded any haemorrhagic complication related to the myomectomy site, and we have also observed a reduced need of diathermy, although we cannot offer an objective measurement of the latter. We believe that a moderate use of diathermy is very important for the quality of the scar and prevention of long-term complications such as uterine rupture. As a matter of fact, reports of such complications following laparoscopic myomectomy [20] and electromyolisis [21] suggest that an extensive use of electro-coagulation can induce myometrial necrosis, which could lead to postoperative fistulae and, eventually, future uterine ruptures.

A possible additional benefit of the use of endoscopic loops is the reduced need of traditional suturing. In our series, only six fibroid beds needed laparoscopic stitches, more frequently the intramural ones. This had implications on operative time, since the myomectomies where additional suturing was not needed were in average 50 min shorter. It is anyway not recommendable to perform such interventions for surgeons lacking solid laparoscopic suturing skills. Moreover, our series only included fibroids with a subserosal component, and we cannot confirm that it would work with totally intramural fibroids.

We have not conducted a systematic second look on our patients. Nevertheless, the only patient submitted to a subsequent GIFT laparoscopy at 6 months from the myomectomy did not have any adhesions on the uterine surface. Evidence exists that myomectomy via laparoscopy can reduce the occurrence of postoperative adhesions [22]. Different reasons could be proposed. First, laparoscopy implicitly follows microsurgical principles, such as atraumatic manipulation and tiny instruments. Additionally, it minimises intraabdominal contamination, reducing flogistic stimuli that could eventually trigger adhesiogenesis. Our personal clinical experience on reproductive outcome after myomectomy showed, through a multivariate analysis, how patients who had been operated laparoscopically had a higher chance of conception [23]. We then argued that this beneficial effect of laparoscopy could be related to a lower occurrence of postoperative adhesions. A technique as the one we are presenting could probably furtherly reduce adhesiogenesis, because of reduced bleeding and need of myometrial suturing, although this is at the moment only an hypothesis.

Conclusions

In expert hands and selected cases, laparoscopic myomectomy represents a safe and effective conservative treatment of fibroids, and a valid alternative to laparotomy [24]. The technique that we are presenting applies to fibroids with at least a subserosal component. It is based on the use of endoscopic loops under progressive tension to avoid bleeding, facilitate enucleation and possibly reduce the need of conventional sutures.

In our experience, the use of loops helps achieving good haemostasis from the perimyomatous myometrium. Moreover, it is our feeling that the need of diathermy was reduced, and that could have a positive effect on the quality of the scar.

The enucleation of the fibroids resulted facilitated by a bloodless field and the squeezing effect induced by the progressive tension on the loops. Although a reduction of number of traditional suturing was observed, we do not recommend this technique to surgeons who are not familiar with laparoscopic suturing.

Overall, the use of endoloops seems to facilitate myomectomy on fibroids with a subserosal component. We believe that this method deserves comparative studies in order to demonstrate its safety and efficacy, also taking into account the relatively low economical impact of the technique.

Conflict of interest No payment or support was received in kind for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis etc.). There have been no financial relationships (regardless of amount of compensation) with any entities that have an interest related to the submitted work.

There have been no nonfinancial associations or interests (personal, professional, political, institutional, religious or other) that a reasonable reader would want to know about in relation to the submitted work.

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