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MINILAPAROSCOPY, NEEDLESCOPY AND MICROLAPAROSCOPY: DECREASING INVASIVENESS, MAINTAINING THE STANDARD LAPAROSCOPIC APPROACH

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Summary.- *OBJECTIVES: To review the development of miniaturized laparoscopic instruments with particular attention to the urological field and focusing on nomenclature, history and outcomes.*

METHODS: A comprehensive literature search was conducted in order to find articles related to Minilaparoscopy, Needlescopy, Microlaparoscopy. The most relevant papers over the last 30 years were selected in base to the experience from the panel of experts, journal, authorship and /or content.

RESULTS: 258 manuscripts were found, 14 of them review, 126 about general surgery, 86 gynecology, 55 urology, 31 thoracic surgery. Minilaparoscopy is the main topic in 169 papers, Needlescopy in 58 and Microlaparoscopy in 32. No clinical randomized trials are available in urology. Most significant articles are 4 prospective non-randomized match-case control.

CONCLUSIONS: We are facing a Minilaparoscopy of second-generation with superior performance granted by new endoscopes and most effective instruments. Up to date, Minilaparoscopy has demonstrated in almost all urologic indication to be feasible, safe and able to improve cosmetic and postoperative pain control. Anyway, clinical randomized trials are still lacking and only studies from other discipline can corroborate this trend.

Keywords: *Laparoscopy. Cosmesis. Microlaparoscopy. Minilaparoscopy. Needlescopy. Scar Assessmement. Urology.*

Resumen.- *OBJETIVO: Revisar en desarrollo de instrumental laparoscópico miniaturizado con atención particular al campo urológico y enfocado en la nomenclatura, historia y resultados.*

METODOS: Se llevó a cabo una búsqueda bibliográfica exhaustiva para encontrar artículos relacionados con minilaparoscopia, laparoscopia con instrumental miniaturizado ("needlescopy"), y microlaparoscopia. Los artículos más relevantes de los últimos 30 años fueron seleccionados en base a la experiencia del panel de expertos, revista, autores y/o contenido.

RESULTADOS: Se encontraron 258 manuscritos, 14 de ellos revisiones, 126 sobre cirugía general, 86 ginecología, 55 urología, 31 cirugía torácica. La mini laparoscopia es el asunto principal en 169 artículos, la "needlescopia" en 58 y las microlaparoscopia en 32. No hay ensayos clínicos aleatorizados disponibles en Urología. Los artículos más significativos son 4 estudios prospectivos no aleatorizados de casos –controles pareados.

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CONCLUSIONES: Estamos frente a una minilaparoscopia de segunda generación con una ejecución superior gracias a los nuevos endoscopios e instrumentos más efectivos. Hasta la fecha, la minilaparoscopia ha demostrado que es factible, segura y capaz de mejorar los resultados cosméticos y el control del dolor postoperatorio en casi todas las indicaciones urológicas. De todas formas, todavía hacen falta estudios clínicos aleatorizados y solo los estudios de otras disciplinas pueden corroborar esta tendencia.

Palabras clave: *Laparoscopia. Cosmética. Microlaparoscopia. Minilaparoscopia. Needlescopia. Evaluación de la cicatriz. Urología.*

INTRODUCTION

Surgeons have undertaken new routes to further reduce trauma and chasing a new concept, the pursuit of cosmetic appearance (Figure1).

The shift from the classic "multi-wound" laparoscopic-surgery to a "single-wound" Laparo Endoscopic Single-site Surgery (LESS) and to a "Scarless" Natural Orifice Translumenal Endoscopic Surgery (NOTES) has been driven by this tendency towards minimally invasive approach (1).

Although these techniques have progressively reduced the invasiveness, they increased the procedure complexity (2). Both LESS and NOTES present a lack of triangulation, needing to manage instruments in a parallel fashion, difficulty to manipulate and dissect tissues, risk of postoperative hernia and absence of specific tools (3). Thus the first not easy to perform, demanding for long training in lab-model, and the latter is still performed only in experimental environment, because safety and superiority over classic procedure a have not been yet confirmed (4).

Recently, other authors tried to decrease invasiveness by preserving the classic tenets of laparoscopy: the triangulation. Some examples are the Small Strategic Laparoscopic Incision Placement (SLIP) (5) hide the incisions in strategic less visible area and the single-incision triangulated umbilical surgery (SITUS) (6): 3 trocars placed through an umbilical incision.

Moreover, the technologic improvement encouraged rediscovering miniaturized laparoscopic instruments. Already in 1977, the introduction in Emergency Laparoscopy of the "Mini and micro-wound" offered by Mini-laparoscopy (ML) (instruments of 3-mm) and Needlescopy (NS) (2-mm) seemed to be promising (7). This refinement of laparoscopic surgery could further reduce his invasiveness with use of 3.5- and 2,5-mm instead of 6- and 13-mm ports. After an initial extensive use in gynecology, ML has been widely experienced in general surgery and now this is the discipline that offers most clinical randomized trials (CRT) in the literature.

ML could offer assistance to LESS and NOTES and even to normal laparoscopy, which is why it should be part of any laparoscopic armamentarium. The purpose of this work is to retrace the route of ML, giving special attention to urological clinical applications.

MATERIAL AND METHODS

A comprehensive electronic English literature search was conducted from January 1977 to June 2011 in order to retrieve article related to Minilaparoscopy (ML), Needlescopy (NS) Microlaparoscopy (mL). PubMed, Medline and Ovid database were used. We retrieved data combining surgical subject heading (MeSH) search terms and related articles function. Keyword searches included: Minilaparoscopy, Needlescopy, and Microlaparoscopy. Selection criteria were based on the journal, authorship and/or content. Case reports were reported only when adding new important information, demonstrating step forward in target achieved and new advances in technical progress. ML-assisted NOTES procedures

FIGURE 1. New routes to pursuit better cosmetic appearance in laparoscopy. Monoscar surgery: granted by Laparoendoscopic single-site surgery (LESS) and Small Strategic Laparoscopic Incision Placement (SLIP). No Scar Surgery offered by Natural orifice Translumenal endoscopic surgery (NOTES).Reduced scar surgery offered by Minilaparoscopy (ML), Needlescopy (NS) and Microlaparoscopy (mL). Masked scar surgery offered by single-incision triangulated umbilical surgery (SITUS)

have been discussed as it emphasizes the tendency to scarless surgery. ML-assisted LESS procedure has not been taken in consideration as pointless to the aim of the review. Because of the lack of CRT in urology, several studies dealing with general surgery and gynecology have been used to retrieve results regarding cosmetic appearance, post-operative pain control and benefits analysis. Pediatric arguments have been discussed in each subspecialty.

RESULTS

We found 258 manuscripts, 19 of them review, 126 regarding general surgery, 86 gynaecology, 31 thoracic and 55 urologic surgery. Among all, 40 papers deal with paediatric topics. ML is the main argument in 169, NS in 58 and mL in 32.

Nomenclature and technology

1. Minilaparoscopy (3-mm). ML-instruments measure 3-mm in size (Figures 2-3) and trocars 3,5-mm. Unfortunately, there has been little or not consensus as to what the appropriate technical definition or terminology should be, nor has it yet been clearly determined how many miniature instruments are required to qualify a ML procedure.

Already Soble and Gill (8) in 1998 give an effort to standardize it. More recently Porpiglia et al (9) reviewed the previous definition.

- For diagnostic/reconstructive procedures, 3-mm instruments should be used exclusively;

- For extirpative procedures requiring specimen extraction, one 10-/12-mm and one 6-mm port are allowed, while all remaining access should be 3.5-mm.

- In each case of retroperitoneoscopy the use of a 10-/12-mm port is not necessary to develop the space. According with Guar (10) and described by Pini and

FIGURE 2. Comparison of Standard 10-mm, 5-mm and 3-mm Minilaparoscopic endoscope and endograsper.

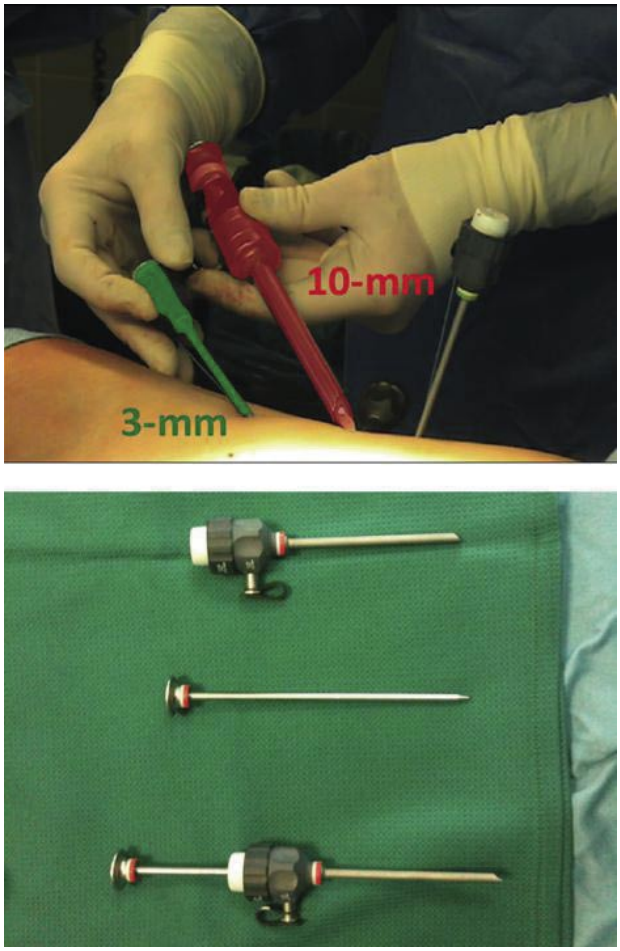

FIGURE 3. Minilaparoscopic (3.5-mm) trocars and comparison with classic trocar.

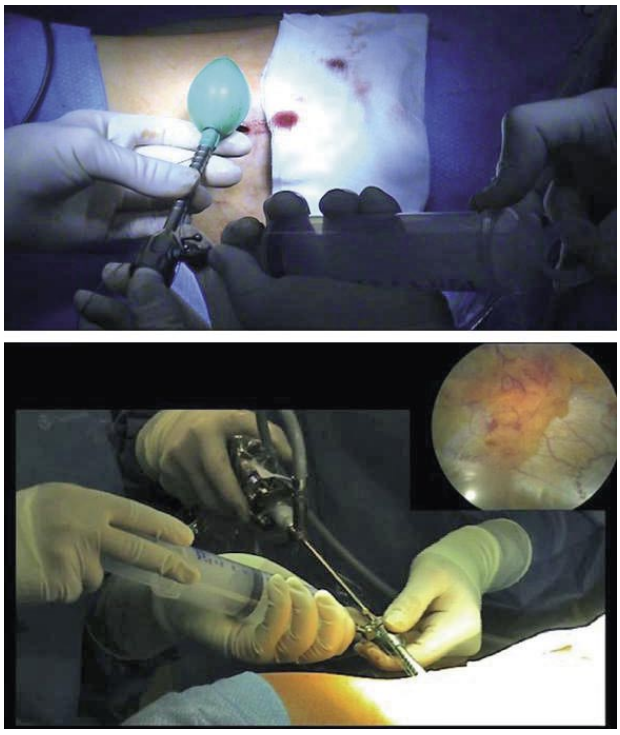

FIGURE 4. Retroperitoneal dissection with a 5-mm home made trocar. In each case of retroperitoneoscopy the use of a 10-/12-mm port is not necessary to develop the space. A home made 5-mm trocar firmly bonded to a 2 finger glove is enough to perform an effective dissection.

Rassweiler (11), an home made 5-mm trocar firmly bonded to a finger glove is enough to perform an effective dissection (Figure 4).

The objective of using 10-, 12-mm and 5-mm ports is to improve laparoscopic vision and to facilitate the alternating use of various instruments, such as a suction cannula and clips applicators. Moreover extirpative procedures require the extraction of the specimen and than a larger final incision is necessary. Therefore, a 12 to 15-mm incision is made at the beginning of the procedure through which could be inserted a larger instrument (8).

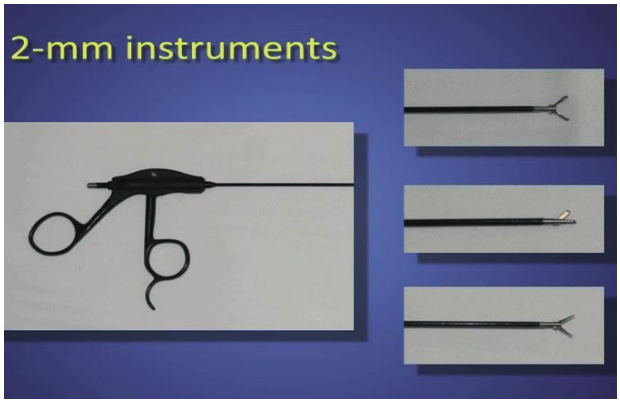

FIGURE 5. Needlescopic 2-mm working Instruments.

2. Needlescopy (2-mm). NS-instruments and scopes presented an external diameter of 2 mm (Figure 5). As such, 2-mm rigid endoscopes, ports, and instruments for NS surgery are currently available. Trocars have an outer diameter comparable to a 14-gauge angiocatheter needle and require only a minute skin puncture for insertion. Earlier reserved for diagnostic purpose only, NS are now being explored for definitive therapeutic procedures as well.

3. Microlaparoscopy (<2-mm). The term "microlparoscopy" (mL) usually refers to endoscopes that are 2-mm in diameter (12). The initial smaller endoscopes were utilized for visually guided access strategies rather than for purposeful laparoscopy itself (13). However, the fiberoptics of these small laparoscopes had very poor resolution, illumination, and optical clarity. The first account of mL was published in 1993 by Risquez and colleagues (14), who used a modified flexible-fiberoptic endoscope to diagnose adhesions.

Obese patients are unsuitable for mL; the short instrument is likely to end up in the extraperitoneal space, and the low insufflation pressures can be insufficient to lift the weight of the abdomen and provide a good view. Patients with multiple adhesions from previous surgery are also less suitable.

Further developments in optics and small instruments could increase the indications for mL. For diagnostic laparoscopy and minor procedures in obstetrics, the results and complications rates have been equivalent to that of standard laparoscopy (15,16) with less postoperative pain and a quicker recovery (17,18).

4. Minilaparoscopic Hybrid Procedure. When a procedure does not fully respect the criteria previously described: for example the use of a 6-mm instead of a 3,5-mm port. This is particularly true in case of difficult procedure or during complicated passage where a 3-mm instrument could be usefully exchanged with a 5-10-mm clips applier.

5. Minilaparoscopic assistance. In daily practice, an adjunctive port is often required, particularly to retract tissue, to offer assistance during a running suture, etc. and the literature offers multiple examples where ML offers assistance during new fascinating technique as LESS, NOTES, SLIP and SITUS. Recently Nicolay et al (19) described on

pigs the effectiveness of a NS-assisted laparoscopic nephrectomy versus LESS approach, showing that restoration of triangulation enable shorter operative times, increased surgeon comfort, improved technical ease, and lower costs while maintaining the scarless cosmesis of traditional LESS protocols.

Clinical applications: other surgical specialities

General Surgery

Most frequent indications for ML are cholecystectomy (20), appendectomy (21), hernia (22), colorectal surgery (23) and diagnostic procedure (24). Cholecystectomy and appendectomy has been intensively investigated and literature provides several clinical randomised trials comparing ML to standard laparoscopy. Two systematic reviews and meta-analyses found 18 studies on cholecystectomy (20) and 4 on appendectomy (21) concluding that ML has a higher conversion rates (compared to laparoscopy), fewer adverse events, improved cosmesis at 1 month and quicker return to activity.

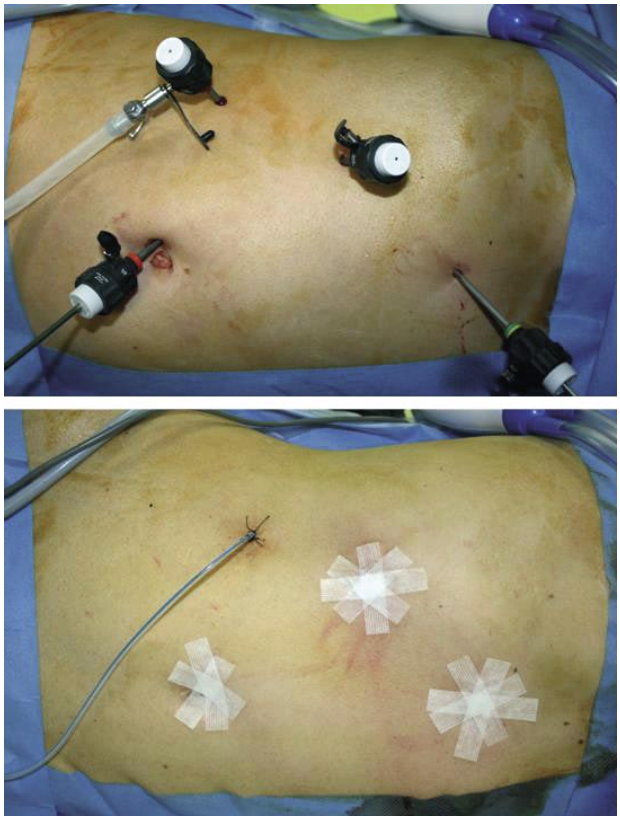

FIGURE 6. Transperitoneal 4-trocar approach for Mini-laparoscopic Pyeloplasty. 4 x 3.5-mm Trocars.

Gynecology

In the past 2 years the literature does not offer lot of experience in this field. Anyway, the transvaginal approach for pure NOTES or ML-assisted procedures and the widespread practice of Office-ML that allow performing different operations under local anesthesia and conscious sedation make gynecology an important discipline for the ML-scenario. Diagnostic field cover: pelvic region assessment in infertile women (25), conscious pain mapping (26), ovarian biopsy (27) and woman sterilization (28). Total vaginal hysterectomy is the gold standard approach but laparoscopy-assistance can be useful. Since 1999, some authors (29,30) evaluated the transabdominal ML- and the mL-assistance even in obese patient (26). Other extirpative applications are myomectomy (31) and partial salpingectomy (32).

Thoracic Surgery

Experience in thoracic surgery is only limited to few preliminary case series describing pulmonary resection and biopsy (33,34), Thoracic sympathectomy (35, 36), thyroidectomy (37), repair of sponteous pneumothorax (38).

Clinical applications in Urology (Table I)

Transperitoneal access in ML

The navel can usually accommodate a 10-12-mm trocar without worsening the final cosmetic result. In extirpative procedure is a prerequisite as port through retrieve the specimen at the end of the procedure. Moreover, it allows the interchange of instruments: clips-applier and Endo-GIA-stapler can here easily allocated, while a smaller endoscope (2-

FIGURE 7. Cosmetic appearance of the scars at 3 months follow up after SMART (Small Access Retroperitoneoscopic Technique) pyeloplasty and standard laparoscopic pyeloplasty.

TABLE I. MINILAPAROSCOPIC CLINICAL EXPERIENCE IN RECONSTRUCTIVE UROLOGIC INDICATION.

Procedure	**Author, Year**	**Instruments / Approach**	**Indication / Population**	**Type of study / Level and grade of Evidence**	**Procedure / Patients / follow up**	**Conclusion**
Ureteral Reimplantation	Tsai et al, 2008 (41)	ML TP (3-mm scope, 2 x 3-mm Instruments)	Congenital Vesi-coureteral reflux	Case series Retrospective (3,B))	14 (9 Pediatric)	safe technique with a better cosmetic results
Orchiopexis / Orchiectomy / excision testicular remnant	Soble and Gill, (8) 1998 Gilll et al, (42) 2000	NS TP (2-mm scope, 2 x 3-mm instruments, + 10-mm in Orchiectomy in Adults	Cryptorchidism	Case series Retrospective (3,B)	12 (10 - 2 Adult)	
Pyeloplasty	Tan, (43) 2001	ML TP (5-mm scope, 2 x 3-mm Instruments)	Congenital UPJO	Case series Retrospective (3,B)	18 (Pediatric)	reduced postoperative pain and results in a "spectacular postoperative cosmetic appearance
	Munteanu, (44) 2007	ML TP (5-mm scope, 2-3 x 3-mm isntruments	UPJO and Pyeloli-thotomy (1 case)	Case report Retrospective (3,C)	2 (Adult)	
	Turial, (45) 2008	NS TP (2,4-mm Scope, 2-3 x 3-mm instruments)	Congenital UPJO	Case Reports (3,C)	2 (Pediatric)	
	Porpiglia, 2011 (In Press)	ML TP (3-mm Scope, 2-3 x 3-mm instrment	UPJO	Prospective non-ran-domized Match-pair controll (2a, B)	12 vs 12 classic laparoscopy (Adult)	Better cosmetic results, comparative
	Pini and Rassweiler, (11) 2011 (In Press)	ML RP (3-, 5-mm scope, 2-3 x 3-mm instruments	UPJO	Prospective non ran-domized Match-pair controll (2°,B)	12 vs 12 classic retroperitoneoscopy (Adult)	Better cosmetic results, Earlier drain removal Effective in experience hand.
Hydrocelectomy	Ho et al (62), 2010	ML TP (3-mm Scope, 2 x 3-mm instruments	Clinical Hydrocele	Case series (3,B)	22 (21 pediatric)	
Inguinal Hernioplasty	Lau and Lee (49), 2002	NS TEP (10-mm Scope, 2 x 2-mm Instruments,)	Congenital Inguinal hernia	Prospective non-ran-domized match-case controll (2a,B)	30 vs 30 classic laparoscopy	Lower postoperative pain upon coughing on pod 1; In 2002 was not available a bipolar forcep.

ML: Minilaparoscopiv; NS: Needlecopic, mL: microlaparoscopy; TP: Transperitoneal, RP: Retroperitoneal, TEP: totally extraperitoneal inguinal hernioplasty, pod: Post operative day, Level of evidence: 2a: Evidence obtained from o
as comparative studies, correlation studies, and case reports. Grade of evidence: B: Based on well-conducted clinical studies but without randomised clinical trials, C: Made despite the absence of directly applicable clinical studies of good quality.

	Tsai et al (48), 2010	ML TAPP (3-mm Scope and 2 x 3-mm Instruments)	Congenital Inguinal hernia	Prospective non-ramdomized comparative cinical trial, (2a,B)	109 vs 65 open Herniorrapphy (pediatrics)	ML was superior to open prevention of contralateral hernia (0% vs 9,7%)occurrence and overall satisfaction
	Lin et al (47), 2011	ML TP (3-mm scope and 2 x 2-mm instruments)	Congenital Inguinal hernia	Retrospective non-ramdomized match-case control, (2a,B)	24 (17 bilateral) vs 31 (9 bilateral) open HErniorraphy Pediatrics	Decrease Longer operative time in monolateral repair.
	Turial et al (46) , 2011	mL + NS TP (1.7-2-mm scope + 2 x 2-mm instruments)		Prospective pilot feasibility study, (2a,B)	140 (100) pediatrics	All procedures were completed microlaparoscopically. Hernia recurrence was observed in 2 patients.
Sex reassignement surgery	De Stefani et al (53), 2004	ML TP scope assistence in craeting the neovaginal cavity.				to decrease the risk of rectal injury related to a blunt dissection usually performed in a blindly manner and only 15 minutes are added to the operation

or 3-mm) is temporary shift in the other working ports.

Retroperitoneal access in ML

Already in 1997, Soble assessed the feasibility of NS-retroperitoneoscopy. However, the lack of a miniaturized balloon-dissector/trocar necessitated placement of a primary 10-mm port (8). In 2000 Kaouk described the development of a rat model for retroperitoneal ML-nephrectomy using 2 and 3-mm instruments (39). In 2002, Gaur illustrated a "mini-version" of his previously described retroperitoneoscopic access through a 5-mm trocar (10,40). By using this approach Pini and Rassweiler described the Small-Access retroperitoneoscopic technique (SMART) approach for pyeloplasty, aiming to offer adults the benefits of ML thereby preserving all advantages of standard retroperitoneoscopy (11).

Reconstructive procedures.

1. Ureteral Reimplantation. In a retrospective analysis, Tsai et al. described a technique for ureteral reimplantation in pt with vesicoureteralreflux using a 3.5-mm port (41). Nine pt were treated with ML nervesparing extravesical ureteral reimplantation without operative complications s and with a high success rate. The authors concluded that this approach was an effective and safe technique with a better cosmetic results and faster recovery in comparison with the open surgical technique.

2. Cryptorchidism. To date laparoscopic-orchiopexy has matured into an established procedure. One relative drawback has been the somewhat large size of the conventional 5-mm and 10-mm ports, compared to the relative small incision offered by the open-approach. In the "milestone" paper regarding NS, Soble and Gill described the first series (5 patients) on orchiopexy (8). Later the same group reported 12 procedures: orchiopexy (2 bilateral), orchiectomy, and diagnostic exploration with attempted excision of testicular remnant (42). NS (2 mm)

optics and instrumentation were used exclusively in the pediatric patients. Orchiectomy required a transumbilical 10-mm port to ultimate specimen extraction.

3. Pyeloplasty. Tan reported his ML-experience concluding that ML significantly enhance the ability to perfome "microanastomosis", reduced postoperative pain and results in a "spectacular postoperative cosmetic appearance" (43). In 2007 Munteanu (44) reported is early results (2 cases) in adult. Interestingly, Turial experimented the use of a 2,4-mm prototype scope to perform 2 pyeloplasty in pediatrics just applying NS 2-mm instruments (45). Porpiglia et al (in press) (Figure 6) presented a prospective matched-pair control for transperitonal Anderson-Hynes pyeloplasty. They confirm better cosmetic and pain controll at 3 months. Similarly, Pini and Rassweiler (11) describe a retroperitoneoscopic (SMART) pyeloplasty providing a matched-pair analysis with standard pyeloplasty (12 pt vs 12 pt). They concluded this is safe procedures in experienced hands, providing better cosmetic results (Figure 7).

4. Inguinal Hernioplasty (iHe). Although the gold standard for inguinal Hernioplasty is the open approach, up to date 17 articles talk extensively about ML approach for Hernia repair offering long-term data follow-up (5-years). Cumulative more than 1700 procedure were analyzed, (976 in paediatric population, 792 total-extraperitoneal, 919 as transabdominal-preperitoneal). Turial et al. (46) shows that a mL-scope (1.7- to 2-mm) offer comparable vision to standard scope. Three prospective studies compare Open versus ML (47,48) and Laparoscopic vs NS (49). The 1st and 2nd showed a less recurrence rates, contralateral metachronous hernia, postoperative pain, complications and functional recovery compared to open approach. The 3rd (NS vs Laparoscopy) show a higher (10%) conversion to open procedure but a mean pain score upon coughing on postoperative day 1 significantly lower. The ML-approach allows the simultaneous exploration of the contralateral inguinal ring and in case of patent processus vaginalis a simultaneous repair (47). This allows over the open approach the prevention of contralateral metachronous iHe (48). The same group described also a safe technique to perform a sac transaction and ligation (50). Shalaby et al (51) showed the superior in an emergency setting like a reduction of incarcerated iHe. Some author (52) conclude that the only drawback of ML repair is the longer operative time in unilateral herniorraphy, which maybe overcome by increased experience.

5. Sex reassignment surgery. The most cumbersome manoeuvre of sex (male-to-female) reassignment is creating a neovaginal cavity inside the perineum. In order to decrease the rectal injury risk related to a a blindly blunt dissection, De Stefani et al (53) reports the advantages offered by a ML-scope with a direct observation of the perineal dissection from inside the peritoneal cavity.

Extirpative procedures

1. Adrenalectomy. The relative small calibre of vessel, the small size of the gland and the unnecessary need for excessive traction make adrenalectomy the most frequently operation performed among the NS-surgery. The procedure is performed using 2-mm-instruments and a 10-mm transumbilical laparoscope (Figure 8). This allow the replacement with a 5-, 10-mm clips applier or 12-mm endo-GIA vascular stapler, while a 2-mm endoscope can be lodged in the other NS port. 13 articles are available in literature (160 procedures). Three papers provide a retrospective comparison with classic laparoscopy.

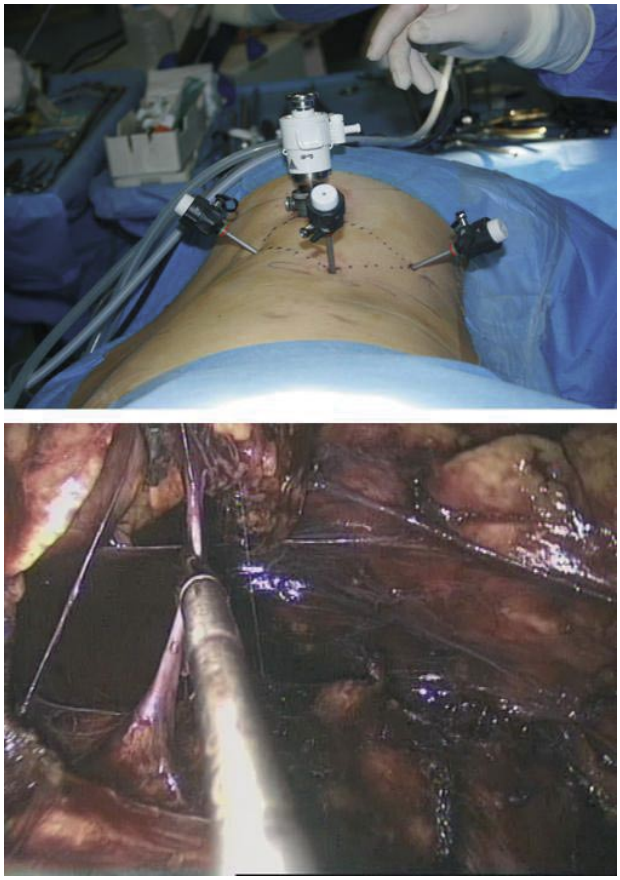

FIGURE 8. Minilaparoscopic Retroperitoneal "clip-less" right Adrenalectomy. Trocar position and Adrenal vein control with minilaparoscopic bipolar forceps.

After that Gnagner et al (54) describe the first NS-adrenalectomy, Gill et al (55) (1998) reported the first series comparing it with conventional laparoscopy (15 vs 21). This retrospective analysis showed shorter surgical time, less blood loss and shorter hospital stays but the authors agreed that a prior experience with conventional laparoscopy is essential before embarking on NS surgery. Chueh (56) in 2002 first described the "Clipless" procedure, characterized by the total control of the vessel with bipolar instrument. This series (12 patients) showed longer operative time (46 minutes) justified by the absence of hemostasis control systems. The most extensive experience in this field belongs to Liao. First in 2006 report is preliminary experience with benign pathology as aldosterone-procucing adenomas, performing a partial-adrenalectomy in 10 case (2 bilateral) obtaining a complete pathological excision and a postoperative normalization of hormones/plasma electrolytes in all patients (57). Then, he reported the largest series actually available (112 patients) (58). The conversion and transfusion rate was respectively 4.5% and 0.9% and they concluded that the NS-instruments are ideal for most adrenal tumor less than 5-mm. Also Pheocromocytomas can be managed but with longer operative time; patients with open surgery might be not suitable candidates for such a technique, remarking the complexity of the procedure (59).

2. Varicocelectomy. In 2002 Sánchez de Badajoz (60) described first the technique performing a Palomo retroperitoneal approach with use of ML-instrument and the transumbilical-scope. In 2011 Chung (61)

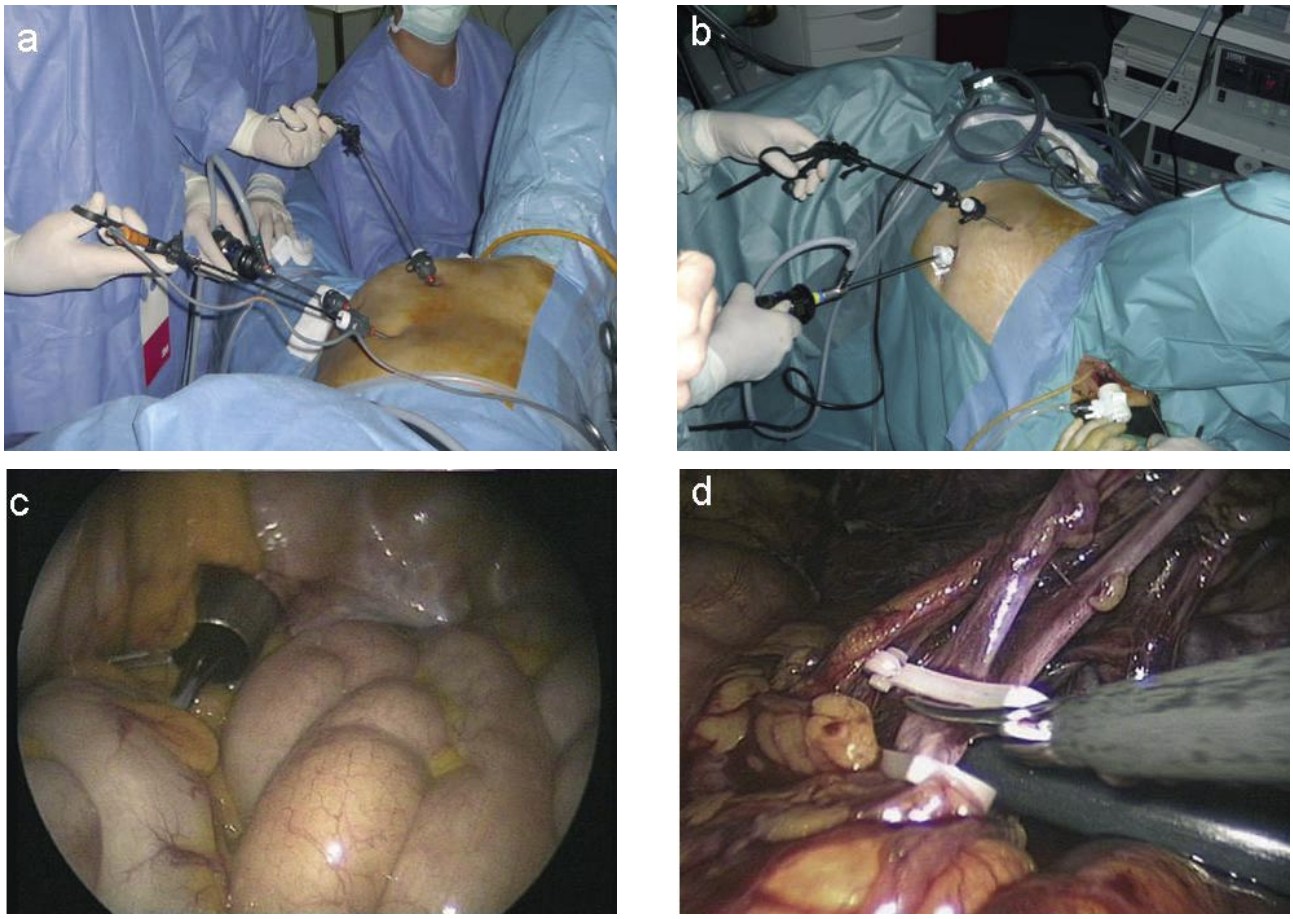

FIGURE 9. NOTES-assisted Minilaparoscopic radical nephrectomy.
a. Pure-Minilaparoscopic approach (3 x 3-mm instruments)
b. Hybrid-Minilaparoscopic approach (2 x 2-mm instruments and 1 x 5-mm instruments)
c. Transvaginal access. A 12-mm port is placed through the vagina into the abdominal cavity, perforating the vaginal wall in the posterior cul de sac under direct vision.
d. Left renal vein is secured with Hem-o-Lok clips and sectioned. The Hem-o-Lok applier is inserted through the vaginal port and utilised by the assistant.

present his large ML-experience (153 procedure) with intracorporeal knot tying and ligation of the internal spermatic veins. All patients were discharged within 24 h after. With a 5 years follow-up they showed surgical results without leading to a high varicocele persistence or recurrence.

3. Hydrocelectomy. Ho et al (62) report their experience with a ML-diagnosis of patented processus vaginalis, detachment from the adjacent peritneoum and closure of the peritoneum over the undissected and left in situ processus vaginalis. In 22 procedures no patients had a ipsilateral recurrence and contra-lateral hernia/hydrocele occurrence. The procedure decreases the risk of spermatic vessels and vas injury and a contralateral synchronous diagnosis and repair.

Other procedures

Soble and Gill (8) reported an initial series in 1998 with NS simple (1), radical nephrectomy (4), simple nephroureterectomy (3), lymphocele marsupialisation (3), Pelvic lymphadenectomy (3), renal cist marsupialisation. No further studies are available in the literature.

Minilaparoscopic assisted natural orfice surgery (MA-NOS)

NOTES is currently under clinical investigation because still presents a number of barriers (63) and only few experiences on human have been performed. Progression to clinical application has been possible by adoption of the new hybrid surgery approach and the Transvaginal-route is the only way that has earned its validation in this scenario thanks to the easiness of access/closure and possibility of retrieval large specimens.

The ML-assisted natural orifice surgery (MA-NOS) provides a solution restoring the trocar triangulation over pure-NOTES approach and solving some disadvantage of pure ML-technique as obtaining a rapid insufflation/forceful irrigation or extraction of large specimens (64). MA-NOS has been shown useful in performing other procedures as cholecystectomy (65,66), radical sigmoidectomy (67), sleeve gastrectomy (67), benign liver lesion treatment (69) and acute appendicitis (65).

MA-NOS in Urology

Porpiglia et al (70) reported a cases series with hybrid transvaginal-NOTES nephrectomy by reducing further invasiveness with the use of 3.5-mm ports instead of the 5- and 12-mm abdominal laparoscopic ports. The Transvaginal port (Figure 9) provided CO2 insufflation, an adeguate suction/irrigation, use of ENDO-GIA and Hem-o-lock, necessary preconditions to perform a radical nephrectomy. The authors report an operative time (120min) comparable to standard laparoscopic technique. During kidney and pedicle dissection the transvaginal assistance port is essential to overcome the technical limitations of ML.

DISCUSSION

Advantage of ML

Placement of a ML or NS port results only in a skin needle puncture, and its closure is secured by the application of a single steri-strip or Dermabond adhesive tissue without need for any sutures. The cosmetic and pain control advantage are superior.

Other advantage is the extreme precision and firmness provided by ML-needleholders during reconstruction. This concept is corroborating by the absence of difference regarding procedural operative time (9,11), even if other older studies show opposite results.

ML-instruments allow even straightening of the needle prior to retrieval from trocar. This example shows that the applied force required is not affected by the calibre of the instruments, even if they are superior over NS-instruments in stability, tissue handling and grasping ability.

We have been facing a second-generation-ML characterized not only by most ergonomic, stronger and flexible tools, but also supported by a HD-system video, allowing for better representation of the third. Even the 3-mm laparoscope offers a stunning image fidelity entirely comparable to standard 10-mm.

The use of ML also has the potential to reduce the risk for trocar-site herniation and to decrease the incidence of wound complications primarily by minimizing the consequences of wound infection.

Soble and Gill (8) suggested that the delicate 2-mm NS instruments, because of their extremely small diameter, have significant potential for causing "inadvertent" injury to the bowel and viscera. Anyway, Demco (88) analyzed complication of mL revealing that the seriousness of the complication is directly dependent on the size of the perforation. Using smaller-diameter trocars and instruments reduces trocar-related injuries to both abdominal wall vessels and intraabdominal organs.

Drawback of ML

First, the quality of laparoscopic vision provided by the 3-mm scope is inferior in terms of image resolution, clarity and light transmitting capacity, in comparison to a 10-mm laparoscope. To improve vision the camera zoom must set to maximum, and this can impair the definition of the image. Moreover, the image is adequate when the operative field is clean, however in case of bleeding, the illumination-induced light absorption causes a substantial decrease in image quality.

Second, ML-clips or Hem-o-lok applicators are unavailable, and this is a clear limitation, in particular when an extirpative procedure is planned. Although the use of bipolar can compensate the lack of a proficient mechanism of coagulation, Platt et al (71) showed in animal experiment the efficacy and the feasibility of the ML-argon coagulator.

Third, NS-instruments are extremely delicate and fragile and the functional capability and tensile rigidity of current 2-mm instrumentation are limited (2, 8).

Fourth, the suction-irrigation cannula, due to its small diameter, has poor flow characteristics and, in some cases, falls to maintain a clear surgical field. The evacuation of smoke can also be compromised by the small-caliber ports, especially when an instrument is inserted.

Fifth, ML is associated with a significant learning curve. The surgeon and all of the surgical crew should become confident with the procedure and should learn necessary tricks, such as compensating the fulcrum effect and tremor due to the small instruments. Additionally, previous laparoscopic experience is demanding.

Finally, ML is not indicated for all patients, and a careful selection, such as non obese patients with no prior abdominal surgery.

Surgical stress response

Yoder (72) provided to compare the surgical stress responses (Cortisol and Glucose production) after hand-assisted laparoscopic (HALS) (Hand-assisted device 7-cm, 12-, 12-mm), standard (12-, 5-, 5-mm) and ML (10-, 5-, 2-mm) nephrectomy in canine model. Even if HALS was faster than other procedures it was associated with a greater operative stress response in the first 2 hours. The stress differences among the techniques were insignificant by 4 hours postoperatively.

By analysing the electroconductivity of representative dermatomes Schmidt et al (73) found that NS provide less sympathetic activity. Anyway, no more difference over laparoscopic cholecystectomy, where evaluable at 1 hour from the operation and VAS presented no difference. This founding can suggest that intraoperative drug administration for analgesia during NS can be reduced as long as the operation time is not prolonged.

Cosmesis

The evaluation of postoperative cosmesis is challenged by the absence of rielable objective scales, potential observer bias, and variation in patients' expectations.

However, randomized trials comparing NS and conventional laparoscopy in general surgery, both patients and blinded observer scored ML-wounds significantly better with regard to cosmetic apperarance (74,75,76).

Although the clinical relevance of differential scarring after small incisions can be questionable, even a small cosmetic benefit may be psychologically, important, especially to relatively young woman (77).

Pain

Decreased incisional pain is a well-established benefit of laparoscopic surgery, and several investigators in non urologic prospective randomized studies have demonstrated that using smaller incisions significantly reduces postoperative pain scores and analgesic requirements (74,76,78-82). However, the direct link between further reduction in the size of access incisions and decreased pain has not been consistently confirmed (75,83). Possible explanations of divergent findings include a multifactorial etiology of postoperative pain, multimodal analgesic regimens that may theoretically overcome the effect attributable to the smaller accesses, and concomitant use of 10- or 12-mm ports in extirpative procedures.

Conscious sedation and local aesthesia (LA)

mL-instruments allow performing limited and precise procedure with LA alone or supplemented by sedation with lower level of Pneumoperitoneum (8-10mmHg).

More than 50 articles are available and the primary application is in gynaecology (infertility, chronic pelvic pain, and tubal ligation, polycystic ovarian syndrome, ovarian drilling and sterilization) (84-86) and emergency and intensive care (diagnostic tool) (87).

TABLE II. MINILAPAROSCOPIC CLINICAL EXPERIENCE IN EXTIRPATIVE UROLOGIC INDICATION.

Procedure	**Author, Year**	**Instruments / Approach**	**Indication / Population**	**Type of study / Level and grade of Evidence**	**Procedure / Patients / follow up**	**Conclusion**
Adrenalectomy	Gnagner et al (54), 1998	NS TP	/	Case report	1	
	Gill et al (55),1998	NS TP (10-mm transumbilical scope, 3 x 2-mm, 5-10-mm clip applier, 10-mm Endo-GIA		Retrospective Match-case controll, (2a,B)	15 vs 21 (Classic laparoscopic) (adults)	
	Mamazza et al (97), 2001	NS TP		Retrospective Match case non-randomized controll, (2a,B)	3 (Adults)	No significant difference in conversion rates, morbidity,or mortality
	Chueh et al (56), 2002	"Clip-less" NS TP, (10-mm transumbilical scope, 2-3 x 2-mm)		Retrospective non-randomized match-case controll, (2a,B)	12 vs 20 classic laproscopy (Adults)	• lower mean analgesic requirement, • lower mean pain and • scar scores and • more rapid convalescence • Similar blood loss, time to oral intake hospital stay were noted in the 2 groups. • longer operative time • A 2 mm. port was converted to a 10 mm (inability to retract liver)
	Liao et al (57), 2006	"Partial Adrenalectomy" NS TP (10-mm transumbilical scope, 3 x 2-mm)	Aldosterone-producing adenomas	Case series	10 (Adult)	
	Liao and Chueh (59), 2008	NS TP	Pheocromocitoma	Case reports	1 (Adult)	

	Liao et al (58), 2008	NS TP	Tumor less tha 5-mm Benign adrenal pathologies (57 aldosterone-producing adenomas, 23 Cushing's adenomas, 12 pheochromocytomas, and 20 incidentalomas) 1 Leiomyosarcoma	Case series	112 (Adults)	Conversion and transfusion rate was 4.5% and 0.9% and. The NS-instruments are ideal for most adrenal tumor less than 5-mm.
Varicocelectomy	Sánchez de Badajoz, Jiménez Garrido (60), 2002	ML TP (3-mm scope umbilical, 2 x 3-mm Instruments)	Scrotal symptomos and/or Infertiilty	Case Series		microlaparoscopic technique not only reduces surgical aggression, but also the risk of complications is less and it does not increase operative difficulty or operation time.
	Chung et al (61), 2011	NS TP (3-mm Scope, 2 x 2-mm insruments	Scrotal symptomos and/or Infertiilty	Case series	153 (87 Adults)	5-year Follow-up. ML approach can preserve spermatic arteries and lymphatic channels without leading to a high varicocele persistence or recurrence.

More CRT (88) demonstrated that sedation decreased the incidence of nausea, vomiting and oropharyngeal pain. It offers a less invasive technique that can be carried out in an outpatient service (89).

Safety in high risk patients and complex procedures

Denzer et al (90) and Hoffman et al (24) investigate the safety of ML-diagnostic liver biopsy in pt affected by impaired coagulation factors. 33% of the 1071 presented serious bleeding that required argon plasma coagulation of the puncture site with an effective and successful action.

Parker et al (91) performed a prospective study about ML direct entry in the left upper quadrant in patients with a previous midline abdominal wall incision. This ML-primary port insertion allowed an excellent view of the peritoneal surfaceand a safe introduction of other ports with any bowel or bleeding complications.

Turial et al (45) conducted a prospective study to determine the value and the feasibility of ML for surgical procedures of advanced complexity in children concluding that ML offer less risk of damage to abdominal organs, the possibility of fewer adhesions and less postoperative pain.

Denzer et al (92) analized cardiorespiratory parameters during ML-exploration and colonoscopy concluding that there is no increased cardiorespiratory risk in diagnostic ML. Differently from diagnostic laparoscopy (93-95), no statistically significant differences in ECG changes were observed in relation to the examination type or the patients' disease status. Moreover, no significant worsening of hemodynamic parameters and respiratory changes was observed, while surgical laparoscopy showed a reduction in cardiac output and a partial decrease in oxygen saturation in patients with severe cardiac disease (ASA III or IV) (96).

Learning curve

Previous clinical trials suggested that a steep learning curve exists for NS and that operative time can be longer than laparoscopic procedures (54, 78, 82). Anyway other studies, even performing high complexity procedures

substantiate this claim (77, 80, 83, 97). We believe that learning curves and operative times are more strongly influenced by the surgeon's background in advanced laparoscopy than by accustomation to smaller instruments. Therefore, progression to NS technique should be undertaken in a stepwise manner, only after acquisition of extensive experience with conventional laparoscopic procedures.

Cost analysis

As introduced by Dequattro (98) and confermed Mezdisnian (86) and Pati (28) mL-tubal ligation under local anesthesia offers the potential for cost savings (a total cost savings for the 29 cases were $16,211) when performed in an outpatient setting by reducing operating time and recovery. Anyway, Garcia et al (18) could not find significant difference in sterilization performed in general anestesia.

Hobart (99) try to elucidate the costs of NS-adrenalectomy. NS showed a 18.1% increase in intraoperative and 63.4% decrease in postoperative charge. Overall NS resulted in a 17.9% decrease in total hospital costs compared to open.

Carvahlo (100) showed in his 1000 series of NS-clipless-cholecystectomy entails a considerable reduction in cost, and, as it does not use the 3-mm laparoscope or disposable materials, it is possible to perform procedure on a larger number of patients. Similar analys were provided by Chou (101).

Recently Nicolay et al (19) evaluated whether the addition of a single 2-mm subcostal port could restore triangulation while not jeopardizing recovery or cosmetic outcome in the porcine model in comparison LESS. They parallel found that the former had significantly lower disposable equipment costs ($363 vs $1696) in comparison of LESS.

CONCLUSIONS

The advantage of reduced size laparoscopic instruments can be insignificant when compared to the progress gained by laparoscopy over the open technique.

ML, NS and mL, fruit of the last generation technology, grant an equal effectiveness as classic instrument, even if there is lacking of basic tools as clips-applier or hemostasis source.

While trocar positions remain in the original setting of classic laparoscopy, the surgeon benefits from the experience already gained. This results in an easier adaptation without establishing a completely new technique in contrary to LESS and NOTES.

Up to date, ML offers better cosmetic results and reduced postoperative pain even if no clinical randomized trials are available in Urology.

ABBREVIATIONS

LESS: Laparoendoscopic single site surgery;
NOTES: Natural Orifice Translumenal Endoscopic Surgery;
SLIP: Small Strategic Laparoscopic Incision Placement;
SITUS: The single-incision triangulated umbilical surgery;
ML: Minilaparoscopy
NS: Needlescopy;
mL: Microlaparoscopy;
CRT: clinical randomized trial;
SMART: Small-Access retroperitoneoscopic technique;
LA: Local Anesthesia

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