Updates in Surgery (2019) 71:419–427
https://doi.org/10.1007/s13304-018-00620-1

REVIEW ARTICLE

Senhance robotic platform for gynecologic surgery: a review of literature

Valerio Rumolo[1] · Andrea Rosati[1] · Alessandro Tropea[2] · Antonio Biondi[3] · Giovanni Scambia[1]

Received: 15 November 2018 / Accepted: 29 December 2018 / Published online: 18 January 2019

Abstract

The advantages of endoscopic procedures are well demonstrated in various surgical procedures. In this field, the technological improvement has been significant. One of the most relevant was made by the introduction of robotic surgery that, thanks to the instruments articulation and the precision of movement, made possible to perform even the most complex procedures. The terms "Alf-X" OR "Senhance" OR "robot" OR "robotic" were systematically used to search the PubMed and Scopus databases. The principal findings considered in the present review were: the study design, the number of patients included in each study, operative time, estimated blood loss (EBL), conversion rate to standard laparoscopy (SLPS) or laparotomy (LPT), post-operative complications, post-operative hospital stay, and the possible advantages and disadvantages reported by the authors of the studies. A total of eight studies were considered eligible for the present review. The average operative time for TH reported was 110–140 min. In two case–control studies, the operative time was significantly prolonged ($P < 0.05$) for robotic procedures when compared with SLPS. The EBL was ≤ 100 ml in all studies. Whereas no statistically significant differences were shown in the two case–control studies in terms of conversion to LPT, all studies were in accordance with the post-operative hospital stay, reporting an average of 2 days for total hysterectomy and 1 day for adnexal surgery.

Keywords Robotic surgery · Senhance · Robotic platform · Hysterectomy · Alf-x · Endoscopy

Introduction

Gynecological surgery represents the gold standard approach for several benign [1–4] as well as malignant diseases [5–7].

The advantages of endoscopic procedures have been well investigated in the past. The benefits are mainly represented by the reduction of post-operative pain, enhanced recovery and, thus, a relevant improvement of quality of life [8–10]. In the last decade, a relevant technological progress was done, thanks to the presence of new laparoscopic appliances such as single port, mini-laparoscopic instruments and percutaneous devices [11–18].

Thanks to these developments, the role of endoscopy has become the gold standard for several benign gynecologic pathologies [19–21], gaining popularity even in oncology [22–33] mainly with fertility-sparing purpose [34, 35].

The most significant technological expansion was made by the introduction of robotic surgery that, thanks to the instruments articulation and the precision of movement, made possible to perform even the most complex procedures [36–38].

Recently, beside the Da Vinci platform, new robotic technology such as the Senhance (Senhance™—Transenterix USA) and the REVO-I Robotic Surgical System (Meere Company, South Korea) are actually available [39]. The Senhance robotic device provides a novel approach to endoscopy thanks to remote 3D vision with an eye-tracking camera control system, an incorporated haptic interaction feedback and high configuration versatility due to total robotic arms independency (Fig. 1) [40, 41].

✉ Valerio Rumolo
valerio.rumolo@gmail.com

[1] Unità Operativa Ginecologia Oncologica, Dipartimento Scienze della Salute della Donna e del Bambino, Fondazione Policlinico Universitario A. Gemelli, IRCCS, L.go Agostino Gemelli 8, Rome, Italy

[2] Department for the Treatment and Study of Abdominal Diseases and Abdominal Transplantation, IRCCS-ISMETT (Istituto Mediterraneo per i Trapianti e Terapie ad alta specializzazione), University of Pittsburgh Medical Center Italy, Palermo, Italy

[3] Department of General Surgery and Medical Surgical Specialties, University of Catania, Catania, Italy

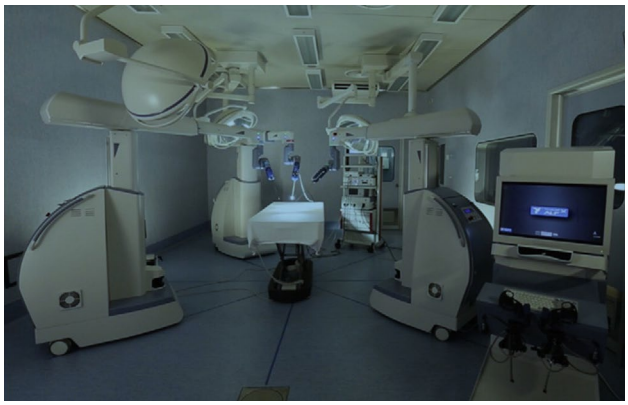

Fig. 1 Senhance robotic platform (cockpit and robotic arms)

A recent study from Hutchins et al. demonstrated that this platform is intuitive, since surgeon's learning and adaptation to the Senhance controls are rapid regardless of the experience level [42].

The present study has the purpose of displaying all characteristics and surgical performances of Senhance robotic platform in gynecologic surgery.

Materials and methods

The present review was conducted to incorporate population criteria, surgical interventions, and outcomes. The systematic search was modeled in agreement with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) [43].

The terms "Alf-X" OR "Senhance" OR "robot" OR "robotic" were systematically used to search the PubMed and Scopus databases. A hand search of the references of both potentially relevant articles and articles qualifying for inclusion was also performed. Original reports in English language were identified, with the purpose of including all relevant papers regarding Alf-x (that was the old name of the platform) and Senhance in gynecologic surgery.

Exclusion criteria included duplicate publications, non-English language literature, video-articles and different fields of application other than gynecology and reviews to avoid repetition of studies results. The flow diagram of the detailed process of articles selection for inclusion in the review is reported in Fig. 2.

In each article, all the possible baseline demographic data and the surgical outcomes were extracted. In particular, the main findings considered in the present review were: the study design, the number of patients included in each study, operative time, estimated blood loss (EBL), conversion rate to standard laparoscopy (SLPS) or laparotomy (LPT), post-operative complications, post-operative hospital stay, and the possible advantages and disadvantages reported by the authors.

The studies were then rated according to the American College of Obstetricians and Gynecologists guidelines [44], which categorize the evidence underlying recommendations into three levels: level A (good and consistent evidence), level B (limited or inconsistent evidence), and level C (consensus and opinion).

Results

A total of eight studies were considered eligible for the present review, published between 2015 and 2018, consisting of six case series and two case–control. In all the selected articles, the strength of recommendation was level B and C and the level of evidence was low.

The most frequent procedures described were adnexal surgery, hysterectomy and pelvic lymphadenectomy (PL). The studies are very heterogeneous regarding the type of surgical procedures performed and the number of patients enrolled. The number of patients enrolled ranged between 4 and 203. All the articles were published by the same research group that investigates different subset of patients and pathologies, both benign and malignant. The first experience started in 2015 when Fanfani et al. [45] and Gueli Alletti et al. [46] reported case series of total hysterectomy ± bilateral salpingo-oophorectomy (TH ± BSO) and ovarian cyst enucleation (OCE), respectively. The oncological cases consisted of early stage endometrial cancer. The average operative time for TH reported was 97–140 min, whereas an average of 197 min was reported for PL. In a study by Fanfani et al. [47, 48], the operative time for hysterectomy performed for benign and oncologic indication was, respectively, a median of 133 and 160 min. Regarding adnexal surgery, mentioned in two studies [46, 48], an average operative time of 35–45 min was recorded. In two case–control studies, the operative time was significantly prolonged ($P < 0.05$) for robotic procedures when compared with SLPS [40, 47]. The EBL was ≤ 100 ml in all studies and in case reports [40, 47] no statistically significant differences were reported compared with SLPS. The conversion rate was divided into conversion to SLPS or conversion to LPT. All the studies selected are in accordance, reporting an average conversion rate of 3–4% and 2–3% to SLPS and LPT, respectively. In one article [45], the conversion rate to LPT occurred in 2/16 cases of PL (12.5%). No differences were reported in the two case–control studies [40, 47] in terms of conversion to LPT. All studies are in accordance with the hospital stay showing an average of 2 days for TH and 1 day for adnexal surgery. In a small case series by Gueli Alletti et al. [49] of TH ± BSO

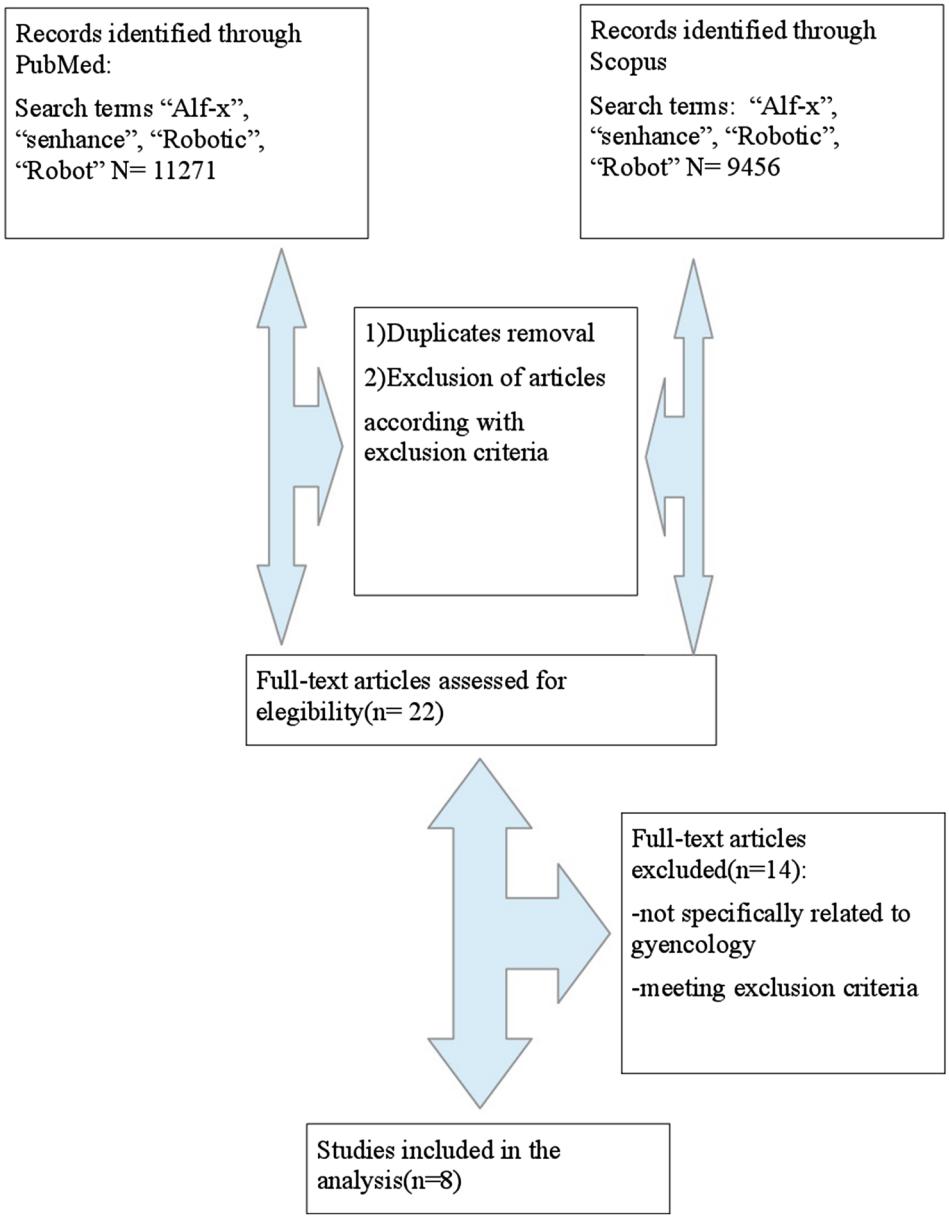

Fig. 2 Flow diagram of the detailed process of selection of articles for inclusion in the review

performed with 3 mm robotic instruments, the median hospital stay was 1 day. No statistically significant differences were demonstrated in case–control studies [40, 47]. Considering the robot characteristics that recreate the standard laparoscopic setting with the same number and size of the trocars, the data are coherent. The complication rate was superimposable in different studies, reporting only one case of major complication (grade 3), consisting of intra-operative bladder injury. The same complication was probably repeated in different studies, considering that the data originated from the same research group. No differences were reported in two case–control studies [40, 47].

Discussion

The present review provides a summary of the available studies regarding a different robotic platform other than Da Vinci that actually is the most widespread and, consequently, the most studied technology.

Considering the literature, only eight studies regarding gynecologic surgery are currently available. The main reason is probably related to the fact that only one research group principally studied this new technology. There are no randomized trials, but only case series and case–control studies. However, various surgical procedures (adnexal

Table 1 Selected studies of Senhance platform in gynecologic surgery

Author, year	Type of study	No. of patients	Type of surgery	Operative time (min) (*p*) mean/median	EBL (ml) Mean/median	Conversions (%)	Hospital stay (days) (*p*) mean/median	Post-operative complications (*p*)	Comments
Fanfani et al. 2015 [45]	Case series	80	*Group 1 (64)* TH ± SOB *Group 2 (16)* PL	*Group 1* Median 140 (range 58–320) *Group 2* Median 197 (range 129–290) $p < 0.001$	*Group 1* Median 20 (range 0–600) *Group 2* Median 50 (range 0–200) $p = 0.237$	*Group 1* 2 (3.1%) to LPS *Group 2* 1 (6.2%) to LPS 2 (12.5%) to LPT	Median 2 (range, 1–5)	*Group 1* 1 (1.6%) grade 3 *Group 2* 0	Senhance is feasible and safe for benign and malignant disease
Gueli Alletti et al. 2015 [46]	Prospective case-series	10	OCE	Median 46.3	/	/	Median 2 (range 1–4)		Senhance is feasible and safe
Gueli Alletti et al. 2016 [40]	Retrospective case control	89 43 RBT 46 LPS	*Group 1* (28 RBT; 31 LPS) TH ± SOB *Group 2* (15 RBT; 15 LPS) PL	*Group 1* RBT median 128 (range, 69–260) LPS median 82 (range, 25–180) $p = 0.000$ *Group 2* RBT median 193 (range, 129–290) LPS median 104 (range, 36–160) $p < 0.000$	*Group 1* RBT median 62 (range 0–500) LPS median 90 (range 0–300) $p = 0.312$ *Group 2* RBT median 60 (range 0–200) LPS median 84 (range 20–200) $p = 0.250$	RBT 2 (4.7%) to LPS 1 (2.3%) to LPT LPS: 1 (2.2%) to LPT p = 0.142	*Group 1* RBT median 2 (range 1–4) LPS median 2 (range 1–5) $p = 0.662$ *Group 2* RBT median 2 (range 2–5) LPS median 2 (range 1–5) $p = 0.487$	RBT 1 (2.3%) grade 3 LPS 2 (4.3%) grade 1 $p = 0$ 0.622	Senhance is feasible and safe for endometrial cancer with longer operative time then SLPS
Fanfani et al. 2016 [47]	Retrospective case–control	203 *Group 1* (88) RBT *Group 2* (115) LPS	TH	*Group 1* Median 147 (range 58–320) in *Group 2* 80 (range, 22–300) $p = 0.055$	*Group 1* Median 57 (range 0–600) *Group 2* Median 99 (range 0–400) $p = 0.963$	*Group 1* 3 (3.4%) to LPS 2 (2.3%) to LPT *Group 2* 0 $p = 0.105$	*Group 1* Median 2 (range 1–5) *Group 2* Median 2 (range 1–4) $p = 0.013$	*Group 1* 1 (1.1%) Grade 3 *Group 2* 3 (2.6%) Grade 3 $p = 0.457$	Senhance is feasible and safe for benign and malignant disease

Table 1 (continued)

Author, year	Type of study	No. of patients	Type of surgery	Operative time (min) (*p*) mean/median	EBL (ml) Mean/median	Conversions (%)	Hospital stay (days) (*p*) mean/median	Post-operative complications (*p*)	Comments
Fanfani et al. 2016 [48]	Prospective case series	146 *Group A* 62 (32.5%) SOM/SOB//OCE *Group B* 4 (2.7%) MY *Group C* 46 (31.5%) TH *Group D* 34 (23.3%) TH (endometrial cancer)	Several common gynecological procedures	*Group A* Median 35 (range 17–145) *Group B* Median 40 (range 10–50) *Group C* Median 133 (range 58–320) *Group D* Median 160 (range 69–290)	*Group A* Median 0 (range 0–200) *Group B* Median 5 (range 0–20) *Group C* Median 20 (range 0–300) *Group D* Median 50 (range 20–600)	*Group A* 2 (3.2%) to LPS *Group B* 0 *Group C* 2 (4.3%) to LPS *Group D* 1 (2.9%) to LPS 2 (5.8%) to LPT	*Group A* Median 1 (1–3) *Group B* Median 2 (1–2) *Group C* Median 2 (2–5) *Group D* Median 2 (1–4)	*Group A* 0 *Group B* 0 *Group C* 1 (2.17%) grade 3 *Group D* 0	95.2% of cases completed with Senhance
Rossitto et al. 2016 [50]	Case series	81	13 TH + − BS 50 RH + − SOB 18 RH + − SOB + − PL	Operative time (SD) 267 (86)	Median 30 (range 0–600) ml.	3 (3.7%) to LPS 2 (2.5%) to LPT	Median 2 (range 1–5)	/	Thel re-usability of instruments, could achieve a cost-reduction
Gueli Alletti 2018 [51]	Case series	10	TH + − SOB	Median 110 (range 70–200)	Median 100 (range 50–200)	0	Median 2 (range 1–4)	0	Procedure is feasible and safe even in obese patients
Gueli Alletti 2018 [49]	Case series	4	TH + SOB	Median 97.5 (range 120)	< 50	0	Median 1 (range 1–1)	0	3 mm instrument have better cosmetic outcome The absence of bipolar grasper represents a limit

TH total hysterectomy, *RH* radical hysterectomy, *SOB* bilateral salpingo-oophorectomy, *SOM* monolateral salpingo-oophorectomy, *SB* bilateral salpingectomy, *PL* pelvic lymphadenectomy, *OCE* ovarian cyst enucleation, *MY* myomectomy, *LPS* standard laparoscopy, *LPT* laparotomy, *RBT* robotic (Senhance)

surgery, hysterectomy and lymphadenectomy) and different subset of patients (obese, oncologic patients) were deeply investigated.

During our analysis, we even reported in Table 1 the authors' comments of each study.

In two different studies [45, 47], Fanfani et al. reported that Senhance platform could be considered an effective and safe option for both benign and malignant gynecologic pathology.

In a case–control study by Gueli Alletti et al. [40], the authors confirmed that the platform represents a feasible solution for patient affected by endometrial cancer, even if the operative time recorded was significantly longer in the robot group; however, the authors commented that the difference could be attributed to the fact that it was the first application of the Senhance system in the surgical management of patients with endometrial cancer.

In another interesting study by Rossitto et al. [50], a cost analysis was reported. The authors commented that thanks to the full re-usability of resterilizable robotic instruments, it is possible to achieve a significant reduction of costs.

In another case series [51], the platform was tested in obese patients demonstrating the feasibility even in this subset of patients. At last, in a small series of four patients reported as letter to the editor [49], the new 3 mm instruments were presented, reducing the cosmetic impact of endoscopic surgery.

Considering all studies available in the literature, Senhance platform represents a hybrid technology located in the middle between laparoscopic and robotic surgery. In fact, the Senhance system balances aspects of laparoscopic and robotic surgery, incorporating advantages of both approaches. In contrast to other robotic platforms, in the Senhance Robotic Platform the surgeon has haptic and tactile feedback, and each arm is independent from the others and can be positioned anywhere in the surgical field through a standard 5-mm trocar placed in the same position as used during SLPS. This last point seems relevant when a conversion from a robotic platform to SLPS or LPT is needed; it is also appreciated by patients because, mimicking the laparoscopic approach, it results in better cosmetic outcomes compared with those obtained with other robotic approaches [40]. Moreover, the cosmetic outcome was recently improved thanks to the availability of new 3 mm robotic instruments reducing the invasiveness. Considering that actually the aspect of quality of life has acquired more importance, even if other factors could be implicated in this aspect [52–68], the invasiveness reduction could represent an important point.

However, evaluating the Senhance in a Robotic environment, the lack of endo-wristed instruments represents the most important limitation: the availability of only one, disposable, 10 mm endo-wristed needle-holder does not represent a determining value.

The majority of the literature available about Senhance is focused on gynecologic surgery even if there are other studies regarding colorectal surgery and cholecystectomies [69, 70] confirming the feasibility of these procedures using this robotic platform.

If on a side, the presence of independent robotic arms represents an advantage in terms of variability in docking and, on the other side, requires large operative rooms and well-trained surgical staff to avoid waste of time in docking procedures; in fact, sometimes the difficulty in finding a correct balance between different instruments could take long time during the docking phase.

Conclusions

Considering all these factors Senhance platform could represent a standard care for gynecological surgery even if some aspects such as operative time and docking procedures should be deeper investigated. Moreover, almost all the studies are focused on pelvic surgery; more research is needed to show the real potential of this technology, especially in other surgical procedures, considering the lack of studies about other specialties as general surgery and urology. At the end in next future, more technological improvements with the aim of reducing the operative time such as incorporated multifunctional instruments will be available.

Funding The work was not supported by any fund/grant.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants and/or animals All procedures performed in studies involving animals were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all subjects.

References

1. Vitale SG, Laganà AS, Noventa M et al (2018) Transvaginal bilateral sacrospinous fixation after second recurrence of vaginal vault prolapse: efficacy and impact on quality of life and sexuality. Biomed Res Int 2018:5727165. https://doi.org/10.1155/2018/5727165
2. Di Spiezio Sardo A, Vieira MDC, Laganà AS et al (2017) Combined systemic and hysteroscopic intra-amniotic injection of

methotrexate associated with hysteroscopic resection for cervical pregnancy: a cutting-edge approach for an uncommon condition. Eurasian J Med 49:66–68. https://doi.org/10.5152/eurasianjmed.2017.16215
3. Vitale SG, Sapia F, Rapisarda AMC et al (2017) Hysteroscopic morcellation of submucous myomas: a systematic review. Biomed Res Int 2017:6848250. https://doi.org/10.1155/2017/6848250
4. Vitale SG, Laganà AS, Gulino FA et al (2016) Prosthetic surgery versus native tissue repair of cystocele: literature review. Updates Surg 68:325–329. https://doi.org/10.1007/s13304-015-0343-y
5. Cignini P, Vitale SG, Laganà AS et al (2017) Preoperative work-up for definition of lymph node risk involvement in early stage endometrial cancer: 5-year follow-up. Updates Surg 69:75–82. https://doi.org/10.1007/s13304-017-0418-z
6. Valenti G, Vitale SG, Tropea A et al (2017) Tumor markers of uterine cervical cancer: a new scenario to guide surgical practice? Updates Surg 69:441–449. https://doi.org/10.1007/s13304-017-0491-3
7. Rossetti D, Vitale SG, Tropea A et al (2017) New procedures for the identification of sentinel lymph node: shaping the horizon of future management in early stage uterine cervical cancer. Updates Surg 69:383–388. https://doi.org/10.1007/s13304-017-0456-6
8. Johnson N, Barlow D, Lethaby A et al (2006) Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.cd003677.pub3
9. Johnson N, Barlow D, Lethaby A et al (2005) Methods of hysterectomy: systematic review and meta-analysis of randomised controlled trials. BMJ 330:1478. https://doi.org/10.1136/bmj.330.7506.1478
10. Gueli Alletti S, Vizzielli G, Lafuenti L et al (2018) Single-institution propensity-matched study to evaluate the psychological effect of minimally invasive interval debulking surgery versus standard laparotomic treatment: from body to mind and back. J Minim Invasive Gynecol 25:816–822. https://doi.org/10.1016/j.jmig.2017.12.007
11. Fagotti A, Bottoni C, Vizzielli G et al (2011) Postoperative pain after conventional laparoscopy and laparoendoscopic single site surgery (LESS) for benign adnexal disease: a randomized trial. Fertil Steril 96:255–259.e2. https://doi.org/10.1016/j.fertnstert.2011.04.006
12. Uccella S, Cromi A, Casarin J et al (2015) Minilaparoscopic versus standard laparoscopic hysterectomy for uteri ≥ 16 weeks of gestation: surgical outcomes, postoperative quality of life, and cosmesis. J Laparoendosc Adv Surg Tech A 25:386–391. https://doi.org/10.1089/lap.2014.0478
13. Caruso S, Panella MM, Cianci S et al (2011) TOT does not affect the urethral sphincter innervation: a pilot study. Int Urogynecol J 22:739–742. https://doi.org/10.1007/s00192-011-1364-9
14. Matarazzo MG, Cianci S, Rampello L et al (2013) Urethral sphincter innervation and clitoral blood flow after the transobturator (TOT) approach. Int Urogynecol J 24:621–625. https://doi.org/10.1007/s00192-012-1891-z
15. Rossitto C, Gueli Alletti S, Rotolo S et al (2016) Total laparoscopic hysterectomy using a percutaneous surgical system: a pilot study towards scarless surgery. Eur J Obstet Gynecol Reprod Biol 203:132–135. https://doi.org/10.1016/j.ejogrb.2016.05.007
16. Rossitto C, Gueli Alletti S, Cianci S et al (2017) Reply. J Minim Invasive Gynecol 24:683–684. https://doi.org/10.1016/j.jmig.2017.02.001
17. Gueli Alletti S, Rossitto C, Perrone E et al (2017) Needleoscopic conservative staging of borderline ovarian tumor. J Minim Invasive Gynecol 24:529–530. https://doi.org/10.1016/j.jmig.2016.10.009
18. Rossitto C, Cianci S, Gueli Alletti S et al (2017) Laparoscopic, minilaparoscopic, single-port and percutaneous hysterectomy: comparison of perioperative outcomes of minimally invasive approaches in gynecologic surgery. Eur J Obstet Gynecol Reprod Biol 216:125–129. https://doi.org/10.1016/j.ejogrb.2017.07.026
19. Laganà AS, Vitale SG, Trovato MA et al (2016) Full-thickness excision versus shaving by laparoscopy for intestinal deep infiltrating endometriosis: rationale and potential treatment options. Biomed Res Int 2016:3617179. https://doi.org/10.1155/2016/3617179
20. Sturlese E, Triolo O, Grasso R et al (2017) Thromboembolism prophylaxis in laparoscopic surgery for gynecologic benign diseases. Results of a single center experience in 922 procedures. Ann Ital Chir 88:342–347
21. Vitale SG, Gasbarro N, Lagana AS et al (2016) Safe introduction of ancillary trocars in gynecological surgery: the "yellow island" anatomical landmark. Ann Ital Chir 87:608–611
22. Cosentino F, Vizzielli G, Turco LC et al (2018) Near-infrared imaging with indocyanine green for detection of endometriosis lesions (Gre-Endo Trial): a pilot study. J Minim Invasive Gynecol 25:1249–1254. https://doi.org/10.1016/j.jmig.2018.02.023
23. Fagotti A, Costantini B, Gallotta V et al (2015) Minimally invasive secondary cytoreduction plus HIPEC versus open surgery plus HIPEC in isolated relapse from ovarian cancer: a retrospective cohort study on perioperative outcomes. J Minim Invasive Gynecol 22:428–432. https://doi.org/10.1016/j.jmig.2014.11.008
24. Paris I, Cianci S, Vizzielli G et al (2018) Upfront HIPEC and bevacizumab-containing adjuvant chemotherapy in advanced epithelial ovarian cancer. Int J Hyperth. https://doi.org/10.1080/02656736.2018.1503346
25. Gallotta V, Conte C, Giudice MT et al (2017) Secondary laparoscopic cytoreduction in recurrent ovarian cancer: a large, single-institution experience. J Minim Invasive Gynecol 25:644–650. https://doi.org/10.1016/j.jmig.2017.10.024
26. Tozzi R, Giannice R, Cianci S et al (2015) Neo-adjuvant chemotherapy does not increase the rate of complete resection and does not significantly reduce the morbidity of visceral-peritoneal debulking (VPD) in patients with stage IIIC–IV ovarian cancer. Gynecol Oncol 138:252–258. https://doi.org/10.1016/j.ygyno.2015.05.010
27. Vitale SG, Caruso S, Rapisarda AMC et al (2016) Biocompatible porcine dermis graft to treat severe cystocele: impact on quality of life and sexuality. Arch Gynecol Obstet 293:125–131. https://doi.org/10.1007/s00404-015-3820-0
28. Petrillo M, De Iaco P, Cianci S et al (2016) Long-term survival for platinum-sensitive recurrent ovarian cancer patients treated with secondary cytoreductive surgery plus hyperthermic intraperitoneal chemotherapy (HIPEC). Ann Surg Oncol 23:1660–1665. https://doi.org/10.1245/s10434-015-5050-x
29. Lagana AS, Vitale SG, De Dominici R et al (2016) Fertility outcome after laparoscopic salpingostomy or salpingectomy for tubal ectopic pregnancy A 12-years retrospective cohort study. Ann Ital Chir 87:461–465
30. Di Spiezio Sardo A, Di Guardo F, Santangelo F et al (2017) Commentary on "Assessment of Risk Factors of Intrauterine Adhesions in Patients with Induced Abortion and the Curative Effect of Hysteroscopic Surgery". J Investig Surg. https://doi.org/10.1080/08941939.2017.1400133
31. Rapisarda AMC, Cianci A, Caruso S et al (2018) Benign multicystic mesothelioma and peritoneal inclusion cysts: are they the same clinical and histopathological entities? A systematic review to find an evidence-based management. Arch Gynecol Obstet 297:1353–1375. https://doi.org/10.1007/s00404-018-4728-2
32. Cianci S, Vizzielli G, Fagotti A et al (2018) A novel HIPEC technique using hybrid CO_2 recirculation system: intra-abdominal diffusion test in a porcine model. Updates Surg 70:529–533. https://doi.org/10.1007/s13304-018-0557-x
33. Cianci S, Abatini C, Fagotti A et al (2018) Hyperthermic intraperitoneal chemotherapy (HIPEC) for peritoneal malignancies

using new hybrid CO_2 system: preliminary experience in referral center. Updates Surg. https://doi.org/10.1007/s13304-018-0578-5
34. Vitale SG, Rossetti D, Tropea A et al (2017) Fertility sparing surgery for stage IA type I and G2 endometrial cancer in reproductive-aged patients: evidence-based approach and future perspectives. Updates Surg 69:29–34. https://doi.org/10.1007/s13304-017-0419-y
35. Chiofalo B, Palmara V, Laganà AS et al (2017) Fertility sparing strategies in patients affected by placental site trophoblastic tumor. Curr Treat Options Oncol 18:58. https://doi.org/10.1007/s11864-017-0502-0
36. Autorino R, Kaouk JH, Stolzenburg J-U et al (2013) Current status and future directions of robotic single-site surgery: a systematic review. Eur Urol 63:266–280. https://doi.org/10.1016/j.eururo.2012.08.028
37. Balachandran B, Hufford TA, Mustafa T et al (2017) A comparative study of outcomes between single-site robotic and multi-port laparoscopic cholecystectomy: an experience from a tertiary care center. World J Surg 41:1246–1253. https://doi.org/10.1007/s00268-016-3799-0
38. Bellia A, Vitale SG, Laganà AS et al (2016) Feasibility and surgical outcomes of conventional and robot-assisted laparoscopy for early-stage ovarian cancer: a retrospective, multicenter analysis. Arch Gynecol Obstet 294:615–622. https://doi.org/10.1007/s00404-016-4087-9
39. Rao PP (2018) Robotic surgery: new robots and finally some real competition! World J Urol 36:537–541. https://doi.org/10.1007/s00345-018-2213-y
40. Gueli Alletti S, Rossitto C, Cianci S et al (2016) Telelap ALF-X vs standard laparoscopy for the treatment of early-stage endometrial cancer: a single-institution retrospective cohort study. J Minim Invasive Gynecol 23:378–383. https://doi.org/10.1016/j.jmig.2015.11.006
41. Gidaro S, Buscarini M, Ruiz E et al (2012) Telelap Alf-X: a novel telesurgical system for the 21st century. Surg Technol Int 22:20–25
42. Hutchins AR, Manson RJ, Lerebours R et al (2018) Objective assessment of the early stages of the learning curve for the senhance surgical robotic system. J Surg Educ. https://doi.org/10.1016/j.jsurg.2018.06.026
43. Shamseer L, Moher D, Clarke M et al (2015) Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ 350:g7647. https://doi.org/10.1136/bmj.g7647
44. Wright JD, Pawar N, Gonzalez JSR et al (2011) Scientific evidence underlying the American College of Obstetricians and Gynecologists' practice bulletins. Obstet Gynecol 118:505–512. https://doi.org/10.1097/AOG.0b013e3182267f43
45. Fanfani F, Restaino S, Gueli Alletti S et al (2015) TELELAP ALF-X robotic-assisted laparoscopic hysterectomy: feasibility and perioperative outcomes. J Minim Invasive Gynecol 22:1011–1017. https://doi.org/10.1016/j.jmig.2015.05.004
46. Gueli Alletti S, Rossitto C, Fanfani F et al (2015) Telelap Alf-X-assisted laparoscopy for ovarian cyst enucleation: report of the first 10 cases. J Minim Invasive Gynecol 22:1079–1083. https://doi.org/10.1016/j.jmig.2015.05.007
47. Fanfani F, Restaino S, Rossitto C et al (2016) Total laparoscopic (S-LPS) versus TELELAP ALF-X robotic-assisted hysterectomy: a case–control study. J Minim Invasive Gynecol 23:933–938. https://doi.org/10.1016/j.jmig.2016.05.008
48. Fanfani F, Monterossi G, Fagotti A et al (2016) The new robotic TELELAP ALF-X in gynecological surgery: single-center experience. Surg Endosc 30:215–221. https://doi.org/10.1007/s00464-015-4187-9
49. Gueli Alletti S, Perrone E, Cianci S et al (2018) 3 mm Senhance robotic hysterectomy: a step towards future perspectives. J Robot Surg. https://doi.org/10.1007/s11701-018-0778-5
50. Rossitto C, Gueli Alletti S, Romano F et al (2016) Use of robot-specific resources and operating room times: the case of telelap Alf-X robotic hysterectomy. Int J Med Robot 12:613–619. https://doi.org/10.1002/rcs.1724
51. Gueli Alletti S, Rossitto C, Cianci S et al (2018) The Senhance™ surgical robotic system ("Senhance") for total hysterectomy in obese patients: a pilot study. J Robot Surg 12:229–234. https://doi.org/10.1007/s11701-017-0718-9
52. Reyes-Muñoz E, Sathyapalan T, Rossetti P et al (2018) Polycystic ovary syndrome: implication for drug metabolism on assisted reproductive techniques—a literature review. Adv Ther 35:1805–1815. https://doi.org/10.1007/s12325-018-0810-1
53. Vitale SG, Caruso S, Rapisarda AMC et al (2018) Isoflavones, calcium, vitamin D and inulin improve quality of life, sexual function, body composition and metabolic parameters in menopausal women: result from a prospective, randomized, placebo-controlled, parallel-group study. Prz Menopauzalny 17:32–38. https://doi.org/10.5114/pm.2018.73791
54. Caruso S, Iraci M, Cianci S et al (2015) Quality of life and sexual function of women affected by endometriosis-associated pelvic pain when treated with dienogest. J Endocrinol Investig 38:1211–1218. https://doi.org/10.1007/s40618-015-0383-7
55. Caruso S, Cianci S, Amore FF et al (2016) Quality of life and sexual function of naturally postmenopausal women on an ultralow-concentration estriol vaginal gel. Menopause 23:47–54. https://doi.org/10.1097/GME.0000000000000485
56. Caruso S, Cianci S, Malandrino C et al (2014) Quality of sexual life of women using the contraceptive vaginal ring in extended cycles: preliminary report. Eur J Contracept Reprod Health Care 19:307–314. https://doi.org/10.3109/13625187.2014.914488
57. Caruso S, Agnello C, Malandrino C et al (2014) Do hormones influence women's sex? Sexual activity over the menstrual cycle. J Sex Med 11:211–221. https://doi.org/10.1111/jsm.12348
58. Caruso S, Cianci S, Malandrino C et al (2013) Hyperandrogenic women treated with a continuous-regimen oral contraceptive. Eur J Obstet Gynecol Reprod Biol 171:307–310. https://doi.org/10.1016/j.ejogrb.2013.09.039
59. Caruso S, Agnello C, Romano M et al (2011) Preliminary study on the effect of four-phasic estradiol valerate and dienogest (e2v/dng) oral contraceptive on the quality of sexual life. J Sex Med 8:2841–2850. https://doi.org/10.1111/j.1743-6109.2011.02409.x
60. Caruso S, Bandiera S, Cavallaro A et al (2010) Quality of life and sexual changes after double transobturator tension-free approach to treat severe cystocele. Eur J Obstet Gynecol Reprod Biol 151:106–109. https://doi.org/10.1016/j.ejogrb.2010.03.016
61. Caruso S, Mauro D, Maiolino L et al (2018) Effects of combined oral contraception containing drospirenone on premenstrual exacerbation of Meniere's disease: preliminary study. Eur J Obstet Gynecol Reprod Biol 224:102–107. https://doi.org/10.1016/j.ejogrb.2018.03.015
62. Caruso S, Cianci S, Vitale SG et al (2018) Sexual function and quality of life of women adopting the levonorgestrel-releasing intrauterine system (LNG-IUS 13.5 mg) after abortion for unintended pregnancy. Eur J Contracept Reprod Health Care 23:24–31. https://doi.org/10.1080/13625187.2018.1433824
63. Caruso S, Cianci S, Fava V et al (2018) Vaginal health of postmenopausal women on nutraceutical containing equol. Menopause 25:430–435. https://doi.org/10.1097/GME.0000000000001061
64. Caruso S, Cianci S, Vitale SG et al (2017) Effects of ultralow topical estriol dose on vaginal health and quality of life in postmenopausal women who underwent surgical treatment for pelvic

organ prolapse. Menopause 24:900–907. https://doi.org/10.1097/GME.0000000000000851
65. Caruso S, Cianci S, Cariola M et al (2017) Improvement of low sexual desire due to antiandrogenic combined oral contraceptives after switching to an oral contraceptive containing 17 β-estradiol. J Women's Health 26:728–734. https://doi.org/10.1089/jwh.2016.5801
66. Caruso S, Cianci S, Cariola M et al (2017) Effects of nutraceuticals on quality of life and sexual function of perimenopausal women. J Endocrinol Investig 40:27–32. https://doi.org/10.1007/s40618-016-0500-2
67. Caruso S, Rapisarda AMC, Cianci S (2016) Sexuality in menopausal women. Curr Opin Psychiatry 29:323–330
68. Caruso S, Iraci M, Cianci S et al (2016) Comparative, open-label prospective study on the quality of life and sexual function of women affected by endometriosis-associated pelvic pain on 2 mg dienogest/30 μg ethinyl estradiol continuous or 21/7 regimen oral contraceptive. J Endocrinol Investig 39:923–931. https://doi.org/10.1007/s40618-016-0460-6
69. Spinelli A, David G, Gidaro S et al (2017) First experience in colorectal surgery with a new robotic platform with haptic feedback. Colorectal Dis. https://doi.org/10.1111/codi.13882
70. Melling N, Barr J, Schmitz R et al (2018) Robotic cholecystectomy: first experience with the new Senhance robotic system. J Robot Surg. https://doi.org/10.1007/s11701-018-0877-3