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Laparoscopic sacrocolpopexy is as safe in septuagenarians or elder as in younger women

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Abstract

Background: Data concerning laparoscopic sacrocolpopexy (LSCP) in elder women are scarce. We compared intra-operative and early-postoperative complications associated with laparoscopic colpo-, cervico-, or hysteropexy in women under and above 70 years.

Methods: Retrospective assessment by an independent investigator of a prospective cohort of 571 consecutive women undergoing LSCP in a tertiary unit over an 18-year period. Data included were patient demographics, operative variables, intra-operative, and early (≤ 3 months) postoperative complications. Complications were graded according to the Clavien-Dindo classification and mesh complications categorized using the International Urogynaecological Association (IUGA)-classification.

Findings: Median age was 66 (IQR 15, range 27-91) and 204 (35.7%) patients were older than 70 years. There were no deaths. Strategic conversion rate was 2.3% (13/571), the majority because of extensive adhesions yet early in our experience. Reactive conversion rate was 0.7% (4/571). Among 554 patients who had a completed LSCP, there were 20 intra-operative complications (3.6%), mostly bladder (1.3%) and vaginal (1.1%) injuries. Eighty-four patients had a total of 95 early-postoperative Dindo ≥ II complications (15.1%). Most common complications were infectious and treated medically (Dindo II). Clinically major complications are rare (III = 3.1% and IV = 0.2%). Reoperation for suspected bleeding (IIIb = 0.7%) was the most common reintervention, typically without demonstrable cause. Most mesh complications were vaginal exposures. Septuagenarians were not more likely to have an intra-operative (4.0 vs 3.3% < 70 years, $p = 0.686$) or early-postoperative complication (13.6 vs 16.0% < 70 years, $p = 0.455$) than younger patients. Mesh complications were also equally uncommon.

Conclusions: LSCP is as well-tolerated by women above 70 years as by younger women.

Keywords: Laparoscopic sacropexy, Elder women, Elderly, Complication, Conversion, Laparoscopy

Background

Clinically visible pelvic organ prolapse (POP) occurs in up to 50% of parous women, half of them being symptomatic [1, 2]. When operated, most patients can be adequately managed by vaginal access. In case of apical descent or a multi-compartment prolapse yet with a so-called level-I defect, abdominal suspension is a better approach [3]. In sacrocolpopexy, the vaginal vault, cervix, or uterus is fixed by means of a graft to the anterior longitudinal ligament over the sacrum. This operation conserves vaginal length; hence, should not compromise its function. Historically, sacrocolpopexy was performed by laparotomy, competing with vaginal sacrospinous fixation, which has a shorter operation time, lower morbidity, and hospital cost, and which can be offered under loco-regional anesthesia. In the 90s, we moved towards laparoscopic sacrocolpopexy (LSCP) and earlier reported on the medium term outcomes [4, 5]. Since 2012, there is level-I evidence that LSCP yields as good anatomical and subjective outcomes as the same

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 2 of 10

operation by laparotomy [6]. Moreover, it is associated with less blood loss, less pain, and a shorter hospital stay. Conversely, operation time, return to normal activities, or functional effects were comparable for both modalities. More recently, this operation is also performed robotically, yet without any proven benefit [7].

Given that the population is aging and that symptomatic POP is more common among the elderly, the number of elder patients eligible for sacropexy will also increase. In 2016, 19.2% of the EU-28-popluation was over 65 years (5.4% > 80 years), and by 2030 that will be 23.9% (7.2% > 80 years) [8]. With increased activity and a healthier population, POP surgery in the elderly will therefore increase accordingly. In one study [9], the annual risk for POP surgery was 4.3/1000 women aged 71–73 years and in another one it was 5.0/1000 women aged 65–69 years [10]. With age, the prevalence of chronic illnesses and comorbidities increases, including poor cardiopulmonary reserve, not to forget, the prevalence of prior surgery [11]. Considering that POP is not a life-threatening condition, surgeons and anesthetists may be reluctant to perform complex and potentially risky operations in the elderly. However, we speculated that, particularly in this population, the choice of minimally invasive surgery is beneficial, because of reduced morbidity, lower transfusion rate, decreased postoperative pain, shorter hospital stay, and faster recovery hence quicker return to normal activity [12].

The relationship between age and complication risk is however controversial. At present, little is known on outcome of LSCP in the elderly. Currently available case series or cohort studies are small to medium sized (≤ 302 patients) with only one controlled study [2] [13] [14]. Most studies show similar complication rates in younger and elder patients, yet occasionally higher complication rates are observed, including for sacrocolpopexy [2]. In the latter study, age ≥ 65 years remained a significant predictor of complications after correction for BMI, estimated blood loss, and operating time (adjusted OR 2.28, 95% CI 1.21–4.29, $p = 0.01$). Herein, we aimed to determine whether in our setting there was an increased risk for intra- or postoperative complications when LSCP is offered to the elder patient. In our unit, sacrocolpopexy is the first choice for the surgical management of level I defects [5], also for elder patients who are judged to be fit for general anesthesia.

Methods

This is a retrospective analysis of a prospective cohort of consecutive patients scheduled for LSCP at the University Hospitals Leuven. Laparoscopy was the preferred route from September 1997 onwards, and all consecutive cases till December 2015 were included. Preoperatively patients were clinically assessed using the pelvic organ prolapse

quantification system (POP-Q) [15]. Sacropexy procedures were either vault suspension ($n = 419$), cervicopexy ($n = 136$), or hysteropexy ($n = 16$), according to the presence or absence of the uterus and the patient's desire to conserve it. The nature of concomitant pelvic floor or other surgery was also noted. LSCP was performed or supervised by an experienced surgeon with a standardized technique and structured training program [16, 17]. Over the years, the only change was the replacement of non-resorbable multifilament polyester by monofilamentary polydioxanone sutures, the abandoning of acellular collagen matrices, and increasingly lighter meshes [17, 18]. These changes were implemented irrespective of the age of the patient. All patients received prophylactic antibiotics (cefazolin and metronidazole unless known allergies). Low molecular weight heparin injections were given until discharge, or longer in case of a history of venous thromboembolism. Midstream urine culture was taken after removal of the catheter. Patients were typically reassessed within 3 months after the operation.

For this study, the electronic medical records were screened by a physician not involved in the surgery or management of the patient. She identified any planned and unplanned hospital visits or any evidence of management for adverse events within 12 weeks after surgery. This includes visits elsewhere at a hospital using our network's electronic medical record system. In the absence of data, the general practitioner was contacted for a follow-up. Post hoc, postoperative complications were categorized using the modified Clavien-Dindo surgical complication classification system [19] and mesh complications by the terminology of the International Urogynecological Association (IUGA) [20]. Previous studies on rectal sacropexy considered Dindo grade III complications as clinically being relevant, hence severe [21]. Other data retrieved included pre-operative characteristics (age, body mass index, menopausal status, diabetes, smoking habits, previous surgery), operative details (operation time, estimated blood loss), and the occurrence and nature of any intra-operative and early postoperative (≤ 12 weeks) complications. Conversions were categorized into either a *strategic* conversion, i.e., instances where the surgeon as a precaution decided to open up the abdomen or to proceed vaginally, or *reactive*, i.e., as a result of an intra-operative complication which the surgeon felt was better managed through open abdomen [22, 23].

Data were entered into a purpose designed database, and statistical analysis was performed using SPSS software (version 24.0, IBM, Armonk, New York, USA). Normality testing was done using the Kolgomorov-Smirnov test. Continuous data were compared using the unpaired Student's t test and categorical data using the χ^2 Fisher exact two-tailed test. Our ongoing prospective follow-up study as well as this audit was approved by the ethical committee on clinical studies (MP10810).

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 3 of 10

Findings

Patient data

During this 18-year period, 571 consecutive patients had a LSCP (Table 1). Their median age was 66.3 years (range 27-91; IQR 14.5). Two hundred four (35.7%) patients were above 70. Of these, 101 (17.7%) patients were above 75, including 26 (4.6%) above 80 and two (0.4%) above 90 years. 73.4% underwent a LSCP after previous hysterectomy, 24.2% had a cervicopexy with concomitant laparoscopic-assisted subtotal hysterectomy (LASH) and 2.8% had a hysteropexy. Twenty-six were redo-sacropexies (4.6%). Concomitant rectopexy, incontinence surgery, or vaginal prolapse surgery was performed in 5.3, 3.7, and 3.0%, respectively.

Conversions

The overall conversion rate was 3.0% or 17 patients with a median age of 68 (range 44-81; IQR 12). There were 13 strategic conversions. In 11 cases, conversion was because of adhesions (1.9%; median age = 67; range 56–76; IQR 11); 9 were completed as open sacropexies (median age 67; range 56–73, IQR 11), and 2 had a vaginal suspension (age 67 and 76) instead. There were two additional patients (age 68 and 72) where visualization of presacral vascular anatomy was judged problematic, and an uneventful open sacropexy was done.

There were four *reactive* conversions (0.7%). One patient (age 68) was converted because of hypercapnia after > 120 min of surgery. Her sacropexy was uneventfully completed via laparotomy. In one patient (aged 81), a large bowel perforation occurred at the time of open laparoscopy. Primary repair of the perforation was done and sacropexy was uneventfully completed by open access, using a non-cross linked 8-layered small intestinal submucosa graft (SIS, Cook, Bloomington, IN) [18]. The postoperative course was uneventful. There were two additional conversions for vascular injury early in the operation, one for epigastric artery injury (age 44) and one left iliac vein laceration (age 60). In both bleeding was controlled by open access and an uneventful open sacropexy was done. None of these patients required a blood transfusion. Overall conversion rate was similar in both age groups (11/367 = 3.0% < 70 vs 6/204 = 2.9%, p = 0.969). In retrospect, there was an early (< 60 cases) peak of strategic conversions, yet thereafter conversions were rare and equally distributed along the experience (Fig. 1). These 17 patients are not further included in statistical analysis as they did not undergo a complete LSCP.
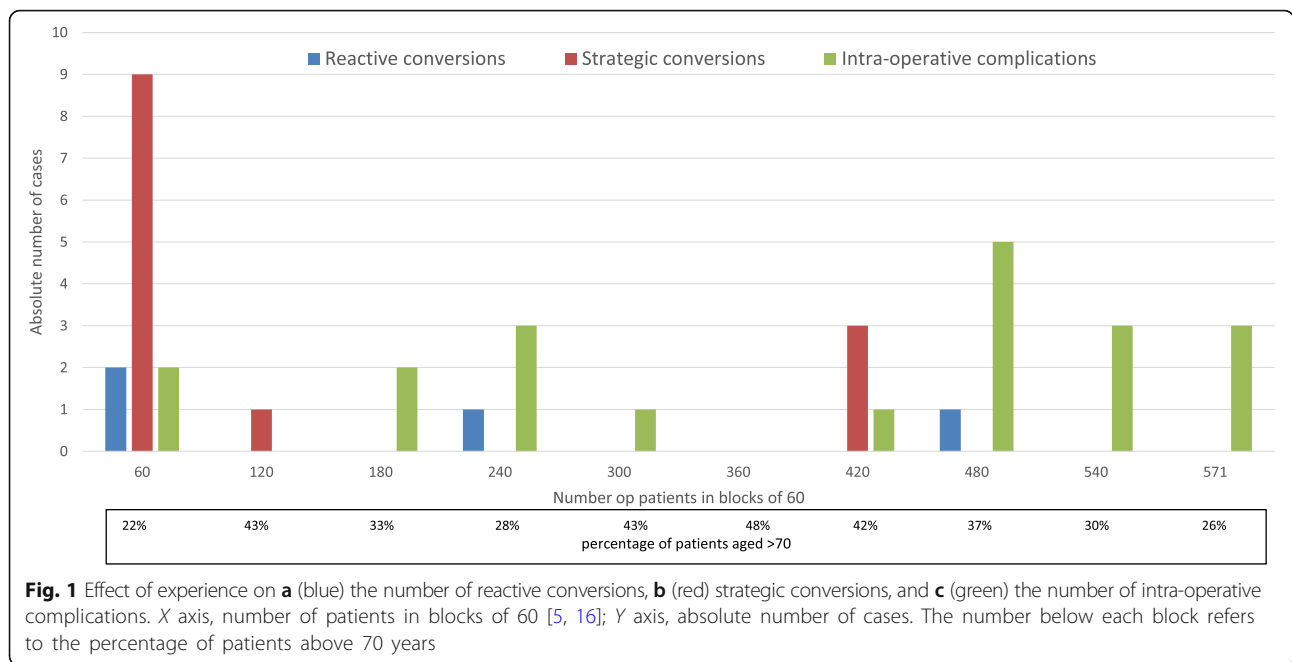
Intra-operative complications without need for conversion

Twenty additional patients had an intra-operative complication, their nature displayed in Table 2 (20/554 = 3.6%). The majority were lesions to the bladder (n = 10),

Table 1 Patient characteristics of the cohort and operative variables for all patients broken down by age category (under and above 70 years)

	Median or %	≤ 70 years	> 70 years	
Number of patients	Total 571 (100%)	367 (64.3%)	204 (35.7%)	
Baseline patient characteristics				p
Age (years)	66 (IQR 15)	61 (IQR 11)	75 (IQR 6)	0.000
BMI (kg/m^2)	25 (IQR 5)	25 (IQR 5)	25.5 (IQR 4)	0.917
Menopausal	90.7%	87.2%	100%	0.000
Diabetes mellitus (all types)	10.8%	9.5%	13.4%	0.344
Current smoker	12.2%	15.7%	3.9%	0.001
Prior hysterectomy	73.4%	70.3%	78.9%	0.025
Prior POP surgery	72.1%	68.9%	77.8%	0.022
Prior LSCP	4.6%	5.7%	2.5%	0.072
Nature of procedures (index operation)				
Sacrocolpopexy	73.4%	70.3%	78.9%	0.025
Concomitant LASH + cervicopexy	24.2%	27.0%	19.1%	0.036
Hysteropexy	2.8%	3.0%	2.5%	0.705
Concomitant rectopexy	5.3%	5.5%	4.9%	0.783
Concomitant incontinence surgery	3.7%	3.6%	3.9%	0.814
Concomitant vaginal surgery	3.0%	3.3%	2.5%	0.584

Abbreviations: *BMI* = body mass index, *LASH* = laparoscopic subtotal hysterectomy, *LSCP* = laparoscopic sacrocolpopexy. Absolute values not displayed; missing values range from prior surgery 0% to certitude on menopausal status 26.4%

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 4 of 10

Fig. 1 Effect of experience on **a** (blue) the number of reactive conversions, **b** (red) strategic conversions, and **c** (green) the number of intra-operative complications. *X* axis, number of patients in blocks of 60 [5, 16]; *Y* axis, absolute number of cases. The number below each block refers to the percentage of patients above 70 years

vagina ($n = 6$), or epigastric arteries ($n = 2$), which were managed laparoscopically. In one patient with hypercapnia, the operation was temporarily suspended for hyperventilation, yet could eventually be completed by laparoscopy. She was afterwards briefly observed in the intensive care unit (ICU), which is a deviation from the normal protocol. In one patient, a suturing needle got detached, fell in the abdomen, and could only be laparoscopically retrieved under fluoroscopy.

Postoperative complications according to the Clavien-Dindo classification

The follow up rate was 100%. Eighty-four women (84/554 = 15.2%) had in total 95 postoperative complications within 3 months (Dindo grade ≥ II; Table 3). Dindo II complications are those events that cause a deviation from the normal postoperative course and that prompt the use of drugs other than analgesics, antipyretics, antiemetics, diuretics, electrolytes, and physiotherapy. Among these, urinary tract infection was the most common (5.9%), the majority identified on urine culture and asymptomatic. Other common Dindo II complications were the need for blood transfusion (1.9%) and the occurrence of postoperative fever/asymptomatic CRP rise treated with antibiotics (1.9%). Dindo III and higher were categorized as major, as earlier described for rectopexy [21]. Interventions without the need for general anesthesia (Dindo IIIa) were for patients with urinary retention and in one patient in office mesh removal and administration of intravenous antibiotics, because of frank mesh extrusion and obvious local infection. She recovered completely and remained without any reintervention without recurrence beyond the observation period.

Reintervention under general anesthesia (Dindo IIIb), and ICU admission (Dindo IV) are clinically very relevant complications. These were rare ($n = 13$, 2.3%). There were four early second look laparoscopies for suspected hemorrhage. Despite a hemoperitoneum, in none of them a true source could be identified.

Table 2 Rate and nature of complications in 554 consecutive patients who had their sacrocolpopexy completely by laparoscopy

Per-operative complications	*n* (%)	≤ 70 years	> 70 years	*p* value
Number of patients	554	356 (64.3%)	198 (36.7%)	
Visceral injuries	16 (2.9%)	10 (2.8%)	6 (3.0%)	0.882
Bladder	7 (1.3%)	5 (1.4%)	2 (1.0%)	–
Ureter	3 (0.5%)	3 (0.8%)	0 (0.0%)	–
Vaginal	6 (1.1%)	2 (0.6%)	4 (2.0%)	–
Vascular injury	2 (0.4%)	0 (0.0%)	2 (1.0%)	0.127
Epigastric artery bleeding	2 (0.4%)	0 (0.3%)	2 (1.0%)	–
Anesthetic problems	1 (0.2%)	1 (0.3%)	0 (0.0%)	1.000
Hypercapnia	1 (0.2%)	1 (0.3%)	0 (0.0%)	–
Other	1 (0.2%)	1 (0.3%)	0 (0.0%)	1.000
Needle detachment	1 (0.2%)	1 (0.3%)	0 (0.0%)	–
Total number	20 (3.6%)	12 (3.3%)	8 (4.0%)	0.686

Abbreviations: –, not calculated because of low number per individual cell.
p values are based on χ^2 testing (Fisher exact)

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 5 of 10

Table 3 Nature and number of 95 early postoperative complications in 83 patients broken down according to the Dindo classification and categorized by age groups. When several complications occurred, the patient was counted in the highest category applicable

Early postoperative complications	n	≤70 years	> 70 years	p value
Number of patients	554	356	198	
Number of patients with complications (% of the population)	84 (15.2%)	57 (16.0%)	27 (13.6%)	0.455
Number of complications	95	61	34	
Dindo II—any deviation from the normal postoperative course requiring pharmacological treatment with drugs other than such allowed for grade I complications	77	53 (14.9%)	24 (12.1%)	0.372
Antibiotics for asymptomatic or symptomatic urinary tract infection	33	24	9	
Antibiotics for postoperative fever and/or CRP rise	11	9	2	
Treatment of vaginal infection	4	3	1	
Antibiotics for umbilical/trocar wound infection	4	4	0	
Antibiotics for chronic obstructive pulmonary disease exacerbation/pneumonia	2	2	0	
Antibiotic prophylaxis after vomiting during extubation	1	1	0	
Blood transfusion	11	6	5	
Administration of (additional) drugs (amlodipine, perindopril, digoxin, bisoprolol, haloperidol)	7	1	6	
Low molecular weight heparin for treatment of deep venous thrombosis/pulmonary embolism	4	3	1	
Dindo IIIa—complication requiring surgical, endoscopic, or radiologic intervention not under general anesthesia	4	1 (0.3%)	3 (1.5%)	0.100
Infection with mesh extrusion, vaginally removed in the office	1	0	1	
Urinary retention, catheterization	3	1	2	
Dindo IIIb—complication requiring surgical, endoscopic, or radiologic intervention under general anesthesia	13	7 (2.0%)	6 (3.0%)	0.429
Reoperation for prolapse	1	0	1	
Reoperation for suspected hemorrhage	4	2	2	
Reoperation for ureter reimplantation	1	1	0	
Reoperation for mesh removal	2	1	1	
Reoperation for exposure sling	1	1	0	
Reoperation: cholecystectomy	2	2	0	
Reoperation for bowel obstruction	2	0	2	
Dindo IV—life-threatening complication	1	0 (0.0%)	1 (0.5%)	0.357
ICU admission for cardiac decompensation and pulmonary edema	1	0	1	

Abbreviations: CRP, C-reactive protein. Statistics were done on individual patient basis for each Dindo category

There were three directly prolapse surgery-related additional surgeries. One 63-year-old heavy-smoking chronic obstructive pulmonary disease (COPD) patient developed vault detachment when awakening with vomiting and coughing. She was reinduced to reattach the mesh to the vault. Because of bronchitis, she was heavily coughing in the postoperative period, leading again to recurrence. Once in remission, we performed a successful abdominal sacropexy 2 weeks later. She remained asymptomatic. There were two reinterventions for mesh-related complications. One 60-year-old patient developed spondylodiscitis (IUGA 6CT2S4), from which she recovered after 9 weeks of antibiotic therapy (including 3 weeks intravenously). She later had a mesh exposure fixed. One 74-year-old patient

developed a severe pelvic infection for which the mesh was removed laparoscopically on day 6. She was postoperatively admitted to ICU (Dindo IV) because of severe dyspnea disappearing with diuretics. She remained under intravenous antibiotics for 14 days. She recovered and did not develop recurrence. In retrospect, this patient had multiple co-morbidities among which essential thrombocytosis, for which she was on the antitumoral agent hydroxycarbamide.

Two patients had a reintervention for bowel obstruction. One 80-year-old had bowel herniation in an abdominal wall hernia. Another 78-year-old had a laparotomy for adhesions 7 weeks postoperatively, requiring partial small bowel resection. Four patients experienced complications away from the operation field. One had a reintervention for a symptomatic sling exposure. Two patients suffered from cholecystitis for which they were operated. One patient who underwent simultaneous LASH was postoperatively diagnosed with a ureteric obstruction at the level of the uterine artery and underwent reimplantation.

Mesh-related complications

There were 15 (2.7%) mesh-related complications, including some already mentioned above (Table 4). Six patients had clinical signs of infection in the mesh area, yet four without loss of vaginal epithelial integrity (IUGA 1CT2 or T3). These were managed by intravenous administration of antibiotics (making them Dindo II complications). Further, there were two patients earlier mentioned. One was the patient with symptomatic exposed mesh removed in the office (3CT2), and the other one was the IUGA 6CT2S4 patients with spondylodiscitis. There were nine small (< 1 cm) suture exposures, eight asymptomatic, and one symptomatic. Most were successfully managed in the outpatient clinic by suture removal. There were no graft-related urinary tract (category 4) or bowel (category 5) complications.

Complications by age group and other patient characteristics

Outcomes in patients under and above 70 years of age are displayed in Tables 1–3. In terms of patient demographics, younger patients were four times more likely

Table 4 Mesh-related complications broken down according to the IUGA classification; with left and right column displaying numbers per age category (under (left) or above (right) 70. Statistics were done by age group for each IUGA CTS-category

General description↓/category→	A		B		C		D		All categories per age group		p value
	≤70 years	> 70 years	≤70 years	> 70 years	≤70 years	> 70 years	≤70 years	> 70 years	≤70 years	> 70 years	
Vaginal complications	Asymptomatic		Symptomatic		Infection		Abscess				
1 No epithelial separation	0	0	0	0	3	1	0	0	3/356 (0.8%)	1/198 (0.5%)	1.000
2 Smaller ≤ 1 cm exposure	7	1	1	0	0	0	0	0	8/356 (2.2%)	1/198 (0.5%)	0.168
3 Larger > 1 cm exposure	0	0	0	0	0	1	0	0	0/356 (0.0%)	1/198 (0.5%)	0.357
4 Urinary tract	Small intraoperative defect		Other lower urinary tract complication or urinary retention		Ureteric or upper urinary tract complication						
	0	0	0	0	0	0			0/356 (0.0%)	0/198 (0.0%)	–
5 Rectal or bowel	Small intraoperative defect		Rectal injury or compromise		Small or large bowel injury or compromise		Abscess				
	0	0	0	0	0	0	0	0	0/356 (0.0%)	0/198 (0.0%)	–
6 Skin and/or musculoskeletal	Asymptomatic, abnormal finding		Symptomatic		Infection		Abscess				
	0	0	0	0	1	0	0	0	1/356 (0.3%)	0/198 (0.0%)	1.000
7 Patient	Bleeding complication		Major degree of resuscitation or intensive care		Mortality						
	0	0	0	0	0	0			0/356 (0.0%)	0/198 (0.0%)	–
Graft-related Complications									12/356 (3.3%)	3/198 (1.5%)	0.277

to smoke. Elder patients were more likely to have undergone previous pelvic floor surgery and/or hysterectomy. Conversely, younger patients were more likely to undergo cervico- or hysteropexy. Operating time was comparable between both age groups as well as length of hospital stay.

When considering by age category, there were no differences in occurrence of *intra-operative* complications (Table 2). Early *postoperative* Dindo categories II, III, or IV complications were not tied to age either. Because of the low numbers in the subcategories of complications, no detailed statistics for those were attempted. Short-term mesh problems were also comparable in both age groups (Table 4).

When analyzing the entire data set, the only correlation with occurrence of complications was having a prior hysterectomy. These patients were less likely to have a complication (RR 0.539 [0.33-0.88]). Actually, this applied in particular to patients under 70, not above. The other factors such as diabetes, menopausal status, prior POP surgery, or prior sacropexy were not associated with an increased likelihood for complications in this data set.

Conclusions
In when reviewing this prospective cohort, an independent researcher meticulously scrutinized the records for any adverse event during their hospital stay and during the first three postoperative months after LSCP. The occurrence of post-discharge complications was based on findings on the routine postoperative visit with us (95.1%), elsewhere with a specialist or in its absence by contact with the general practitioner (4.9%). This resulted in a 100% short-term follow-up rate, which is possible in a small country like Belgium. In addition, our complication and conversion rate is comparable to what was observed in other large series [2, 24]. Therefore, we think the results of our study are representative.

Though the use of terms as "severe," "major," or "minor" for complications is discouraged [19], the clinical relevance of the occurrence of what we categorized as "severe" cannot be debated, because of their potential life-threatening impact. There were a few severe intra-operative complications, some of them leading to reactive conversions. The most relevant ones were hemorrhagic in nature. Three were epigastric bleedings, which early on in our experience still prompted a conversion in one, yet later such complication was easily managed laparoscopically. Epigastric artery bleeding is also reported by others, yet is to some extent avoidable [2, 24]. We report one laceration at the inferior border of the iliac vein, a well-known and feared complication of sacropexy. That is probably the reason why we were ready to compress the vein immediately with a swab.

Despite adequate control of the situation, the vascular surgeon preferred to perform an open repair. Others have reported laparoscopic management of such event [25]. There was one bowel perforation diagnosed during entry by open laparoscopy, hence without clinical consequences. In case of potential bacterial contamination, we do not use durable mesh as it may get permanently colonized, yet use in that case resorbable biografts despite poorer outcomes [18, 26]. The other intra-operative complications, such as bladder or vaginal perforations, can easily be managed laparoscopically with no clinical consequences. These were also frequently reported by others [2, 14, 24]. Also, hypercapnia can be managed, either by conversion or by pausing the intervention. None of the above intra-operative complications seem to us directly age-related neither are they are avoidable by cautious patient selection.

There were also a number of severe *postoperative* complications. There was the patient with discitis, which required prolonged use of antibiotics, yet no mesh removal. Discitis is a debilitating complication, which may require multiple reinterventions. It has been tied to the use of staples or tackers, yet it has also been reported when sutures are used and after open repair [27, 28]. Discitis is uncommon so typically individual cases are reported or will only surface in large series. We do not see any reason why it would be age-related. We had another severe local infectious complication. This woman presented with clinical signs of pelvic infection so we thought the mesh was infected. She was so sick she was admitted to ICU and underwent mesh removal, after which she fully recovered. In retrospect, we probably underestimated her co-morbidities and could have offered her an alternative surgical technique. A third complication, which was also in part infectious, was the COPD patient with chronic cough and respiratory infection, in whom coughing caused early release of the vault. She was successfully reoperated (Dindo IIIb) when her respiratory problems were solved. We preoperatively felt she should have sacrocolpopexy after two earlier failed vaginal repairs. There were also two obstructions, one because of adhesions. Though we always peritonealize, adhesions are unavoidable, except when choosing a vaginal extraperitoneal alternative, like sacrospinous fixation. Another striking complication is postoperative bleeding. Though clinically there was intra-abdominally convincing evidence of previous bleeding, we could never identify an active source. Postoperative hemorrhage is not the privilege of abdominal procedures, neither is it more likely in the elderly.

This study was essentially undertaken to investigate whether LSCP is justifiable in the elder population. In our series, we did not find a higher risk in patients above 70 years of age. This was neither the case when we took a lower (65 years) or higher age cut off (data not shown). The same observation was made by others, though all

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 8 of 10

studies with another age cut off (range 65–80 years) [2, 13, 14]. This is also in line with observations following abdominal sacrocolpopexy [29]. Conversely, Turner et al. observed a higher major complication rate following laparoscopic or robotic sacrocolpopexy in women ≥ 65 years, both unadjusted (OR 1.84, 95% CI 1.02–3.35, p = 0.04), yet also after adjustment for BMI, estimated blood loss (EBL) and operating room time (OR 2.28, 95% CI 1.21–4.29, p = 0.01). The authors were unable "to reliably attribute the increased risk in the elderly" to the particularities of minimal invasive surgery in this population [2]. We did not correct for EBL or operating time, as they are dependent on concomitant surgery and because EBL cannot be accurately measured. Also, BMI was comparable in our patients with and without severe complications. Also in other surgical disciplines, laparoscopy is the preferred access route in the elderly, such as for cholecystectomy [30] or colonic surgery, including for cancer [31, 32]. Also rectopexy, which technically is very comparable to LSCP, can be safely offered to the elderly [33]. In brief, elder patients are in fact the ones who benefit the most of avoiding a laparotomy.

Our study definitely has its weaknesses. One limitation is generic in nature as it is due to the inherent limitations of the used classifications systems. The Clavien-Dindo grading system does not necessarily refer to the clinically most relevant complications. On the one hand, it identifies asymptomatic urinary tract infections (UTI) treated by a single course of oral antibiotics (or any other one time used drug such as an antihypertensive) as a Dindo II complication. Short lasting per-oral drug administration is barely considered as a complication by patients and physicians. Moreover, some of these complications, like UTI, are only picked up because one screens for it, hence may never be symptomatic. Along the same lines, also the IUGA mesh complication system identifies asymptomatic exposures as a grade 2A complication, including a suture exposure. Such complications are obviously clinically irrelevant, whatever the age of the patient. Conversely, the Dindo classification system underestimates relevant incidents like transient neurological symptoms, such as sensory or motoric dysfunction in the lower limbs, which we tied to wrong positioning of the patient [5]. Though they only required prolonged physiotherapy and other conservative measures, and eventually fully recovered, this is a tangible complication for the patient and the healthcare system. It however qualifies as a Dindo I complication, hence was not included here. Moreover, in the elderly any limitation in mobility is adversely influencing outcome. Briefly, the limitation of the Dindo classification is that it is based on the nature of the intervention prompted by the complication. In that respect, the IUGA/ICS mesh-complication classification is more patient-centered.

We acknowledge a number of other limitations. Though based on a large prospective cohort, it remains a retrospective audit on what eventually stays a selected population of women judged to be fit for general anesthesia (hence, not the others). Retrospective studies have the potential of underreporting. We have tried to tackle this limitation, by [1] including all consecutive cases; [2] having the data audited by a third person not involved in the management of the patient [3]; in the absence of physical postoperative visit of the patient, we used the electronic medical record system used in a network of hospitals and [4] contacted where necessary the general practitioner of the patient. The latter two increased the follow-up rate from 95 to 100%, yet it is possible that a number of events may have been missed. Another potential confounder is that quite some patients had concomitant procedures, which on themselves may have caused complications. We decided to assume they were tied to the LSCP, which might be an overestimation. Conversely, we reported reactive conversions separately, hence did not include them in the statistics of procedures done completely by laparoscopy, as did Vandendriessche et al. [34]. In order to disclose them, we reported them separately in detail.

Another problem is that, despite the large cohort, the ultimate incidence of rare events limits statistical comparison between age groups. We therefore aggregated categories of complications to reach reasonable numbers. Obviously, these small numbers also limit the justified use of multivariate analysis for other factors than age. Further, we do not report outcomes on alternative procedures, such as sacrospinous fixation or colpocleisis, performed during the same period. This would be neither correct, as the selection criteria for these procedures were not exactly the same. To finish, we realize this is only a report on short-term outcomes, yet the functional and long-term outcome of this cohort is the subject of another study.

This study has however its strengths. To our knowledge, this is the largest cohort study looking into complications with a 100% short-term follow-up rate. It is a consecutive series of standardized operations at a single center, yet with both experienced operators and subspecialists in training. Finally, the assessment was done by a clinician not involved in the surgical management of the patients. Given that our overall outcomes fall in the range of what is expected, we believe the conclusion of this study stands.

In conclusion, in this large prospective cohort intraoperative and severe (Dindo III and IV), early postoperative complications occurred in 3.6 and 2.3%, respectively. Older age at the time of intervention was not associated with additional morbidity. Therefore, we conclude that LSCP appears to be well-tolerated and safe in elderly women with level I defects and without contra-indication for general anesthesia.

Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 9 of 10

Abbreviations
BMI: Body mass index; CI: Confidence interval; COPD: Chronic obstructive pulmonary disease; EBL: Estimated blood loss; EU-28-population: European Union of the 28 countries-population; ICU: Intensive care unit; IQR: Interquartile range; IUGA: International Urogynaecological Association; LASH: Laparoscopic-assisted subtotal hysterectomy; LSCP: Laparoscopic sacrocolpopexy; OR: Odds ratio; POP: Pelvic organ prolapse; POP-Q: Pelvic organ prolapse quantification; RR: Relative risk; SPSS: Statistical Package for the Social Sciences; UTI: Urinary tract infection

Availability of data and materials
The dataset is available with the corresponding author.

Disclosures
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Authors' contributions
KV, SH, SP, GC, FVDA, AW, ADH, PR, and JDP did the clinical management of the patients involved, both at the pre- and postoperative outpatient setting and perioperative follow-up. KV, SP, GC, and LC did the data collection. KV and JDP did the data analysis. All authors contributed to manuscript writing, read, and approved the manuscript.

Competing interest
We received an investigator-initiated research grant from Johnson & Johnson for an initial audit of sacropexy patients. Both the study protocol, data analysis, interpretation and reporting, as well as the manuscript were made without interference of the company.

Authors' information
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Ethics approval and consent to participate
Our ongoing prospective follow-up study as well as this audit was approved by the Ethical Committee on Clinical Studies of the UZ Leuven (MP10810), and patients gave informed consent for the prospective follow-up study.

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Vossaert *et al. Gynecological Surgery* (2018) 15:11

Page 10 of 10

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