Does ovarian suspension following laparoscopic surgery for endometriosis reduce postoperative adhesions? An RCT

Wee Liak Hoo*, Andreas Stavroulis, Kate Pateman, Ertan Saridogan, Alfred Cutner, George Pandis, Edward N.C. Tong, and Davor Jurkovic

Women’s Health Division, University College Hospital, 235 Euston Road, London NW1 2BU, UK

*Correspondence address. E-mail: willhoo@hotmail.com

Submitted on August 26, 2013; resubmitted on December 28, 2013; accepted on January 6, 2014

STUDY QUESTION: Is temporary ovarian suspension following laparoscopic surgery for severe pelvic endometriosis an effective method for reducing the prevalence of postoperative ovarian adhesions?

SUMMARY ANSWER: Temporary ovarian suspension for 36–48 h following laparoscopic treatment of severe endometriosis does not result in a significant reduction of postoperative ovarian adhesions.

WHAT IS KNOWN ALREADY: Pelvic adhesions often develop following laparoscopic surgery for severe pelvic endometriosis. Adhesions can cause chronic pelvic pain and fertility problems compromising the success of treatment. Small observational studies suggested that temporary postoperative ovarian suspension to the abdominal wall may significantly reduce the prevalence of postoperative ovarian adhesions.

STUDY DESIGN, SIZE, DURATION: This was a prospective within group comparison double-blind RCT. We recruited premenopausal women with severe pelvic endometriosis who required extensive laparoscopic surgery with preservation of the uterus and ovaries. Severity of the disease and eligibility for inclusion were determined at surgery. A total of 55 women were randomized to unilateral ovarian suspension for 36–48 h, 52 of which were included in the final analysis. Both ovaries were routinely suspended to the anterior abdominal wall during surgery. At the end of the operation, each woman was randomized to having only one ovary suspended postoperatively. The suture suspending the contralateral ovary was cut and a new transabdominal suture was inserted to act as a placebo. Both sutures were removed 36–48 h after surgery prior to discharge. Three months after surgery, all women attended for a detailed transvaginal ultrasound scan to assess ovarian mobility. The primary outcome was the prevalence of ovarian adhesions as described on ultrasound examination. Secondary outcomes were the severity of adhesions and the presence and intensity of postoperative pain.

PARTICIPANTS/MATERIALS, SETTING, METHODS: All 55 participants had severe pelvic endometriosis confirmed at laparoscopy. As each participant had only one of their ovaries suspended at the end of surgery, they acted as their own control.

MAIN RESULTS AND THE ROLE OF CHANCE: The median interval between ovarian suspension and postoperative scan was 99 days (interquartile range 68–114). There was no significant difference ($P = 0.23$) in the prevalence of postoperative ovarian adhesions between the suspended (20/52) and unsuspended (27/52) side (38.5 versus 51.9%) [odds ratio 0.56 (95% confidence interval 0.22–1.35)].

LIMITATIONS, REASONS FOR CAUTION: Ovaries were suspended postoperatively for 36–48 h. Longer suspension could result in lower prevalence of postoperative adhesions.

WIDER IMPLICATIONS OF THE FINDINGS: The value of temporary ovarian suspension in women having surgery for mild-to-moderate endometriosis should be investigated further. The potential benefits of other adhesion prevention strategies, such as surgical barrier agents, in women undergoing surgical treatment for severe pelvic endometriosis should also be explored.

STUDY FUNDING/COMPETING INTERESTS: E.S. received honoraria from Ethicon for provision of training to healthcare professionals and consultancy fees from Bayer. W.H. was supported by the research fund provided by the Gynaecology Ultrasound Centre, London UK. A.C. is...
**Introduction**

Endometriosis is an important cause of morbidity in premenopausal women. Typical symptoms of endometriosis are dysmenorrhoea, dyspareunia, chronic pelvic pain and subfertility which often have significant negative impact on women’s quality of life. Surgical excision is the most effective treatment for severe pelvic endometriosis. Currently, endometriosis surgery tends to be performed using a laparoscopic approach which provides superior views of the pelvic organs and facilitates complete excision of endometriotic lesions (RCOG Greentop Guideline No. 24, 2006). Although laparoscopic surgery is considered to be less traumatic to pelvic tissues than open surgery, a significant number of women develop postoperative pelvic adhesions even after this form of surgery. Postoperative adhesions most commonly affect the ovaries and the pouch of Douglas (Diamond, 1991) and they can cause chronic pelvic pain, dyspareunia, intestinal obstruction and infertility (diZerega, 1994). Reported prevalence of pelvic adhesions following laparoscopic surgery for severe pelvic endometriosis varies between 50 and 100% (Operative Laparoscopy Study Group, 1991; Redwine, 1991; Canis et al., 1992; diZerega, 1994).

A wide range of interventions has been tried in the past in order to reduce postoperative pelvic adhesions. They include intra-peritoneal administration of anti-adhesive solutions such as icodextrin and hyaluronic acid. Various drugs including steroids and heparin have also been tried in the past but none of them has gained wide acceptance (Metwally et al., 2006; Kamel, 2010). Oxidized regenerated cellulose was found to reduce postoperative adhesion in two very small RCTs (Ahmad et al., 2008).

Intra-operative suspension of the ovaries to the anterior abdominal wall is sometimes used to facilitate ovarian retraction during surgery for severe pelvic endometriosis (Cutner et al., 2004). Two small observational studies suggested that temporary ovarian suspension for 4–7 days following surgery for severe endometriosis may reduce the frequency of postoperative pelvic adhesions (Abuzeid et al., 2002; Ouahba et al., 2004).

The aim of this prospective RCT was to assess the effect of temporary ovarian suspension following laparoscopic surgery for severe pelvic endometriosis on the prevalence of postoperative ovarian adhesions.

**Materials and Methods**

This was a prospective within group comparison double-blind RCT which was conducted at the University College London Hospital Endometriosis Centre. The Centre is a tertiary referral unit for women with severe pelvic endometriosis and receives patients from a wide area of South East England. Participants were invited to join the study. Suitability for randomization was determined at surgery. Women with evidence of severe endometriosis requiring extensive dissection of both pelvic side walls and/or rectovaginal space with preservation of the ovaries and the uterus were included in the study.

Exclusion criteria were inability or unwillingness to provide written consent, inability to tolerate a transvaginal ultrasound scan, failed or incomplete excision of endometriosis and surgical complications leading to unplanned oophorectomy, bowel injury or conversion to open surgery.

**Interventions**

During laparoscopic treatment for severe endometriosis, both ovaries were routinely suspended to the anterior abdominal wall using a Prolene suture (Ethicon Inc., Somerville, NJ, USA) which was brought out onto the skin and secured using a fine haemostat or ‘mosquito’ clip during surgery. This was performed to facilitate access to the pelvic side walls during the operation and a complete excision of the disease. Depending on the abnormalities present, the surgical procedures included mobilization of adherent ovaries, removal of ovarian cysts, opening the pelvic side wall peritoneum and dissecting out the ureters, dissection of obliterated pouch of Douglas and excision of superficial and deep endometriotic lesions.

At the end of the operation, women were randomized to have one ovary suspended for 36–48 h postoperatively. One of the two ovarian suspension sutures was cut to allow that ovary to fall back into the lesser pelvis. A new transabdominal suture was then re-inserted at the same site to act as a placebo. The pneumoperitoneum was deflated and the Prolene suture of the suspended ovary was tightened with a surgical knot placed over the skin to secure the ovary to the abdominal wall. This was done to ensure that the suspended ovary was lifted as far away from the pelvic side wall as possible. A surgical knot was secured with the space of a straight surgical suture cutting scissors between the skin and the knot to allow easier removal of the suture and reduce patient discomfort. All randomized patients therefore had two abdominal sutures of similar length. The patient and clinical staff were blinded to the randomization. The only staff members who were aware of the site of ovarian suspension were the surgeons who were under strict instructions not to discuss individual patient’s treatment allocations with the patient or any other members of the clinical and nursing staff. Both sutures were cut 36–48 h after surgery by a ward nurse who was not part of the operating or research team and who was blinded to the ovarian suspension site.

**Follow-up**

Three months after ovarian suspension, all women were scheduled for a transvaginal ultrasound scan to assess ovarian mobility. Ovarian adhesions were diagnosed in women with evidence of restricted ovarian mobility on targeted palpation using a transvaginal ultrasound probe (Holland et al., 2010). The ultrasound operators were blinded to the details of the operative procedure and women’s randomization allocation.

**Outcome measures**

**Primary outcome measure**

The primary outcome was the prevalence of ovarian adhesions on ultrasound 3 months after surgery. The presence of ovarian adhesions was assessed by a...
combination of gentle pressure with the vaginal probe and abdominal pressure with the examiners free hand, as on bimanual examination. The presence of ovarian adhesions was diagnosed when the ovarian mobility was restricted and the ovary could not be separated from the peritoneum of the lateral pelvic wall and/or pouch of Douglas.

Secondary outcome measures
Secondary outcomes were changes in clinical symptoms and severity of ovarian adhesions. The severity of pelvic pain was assessed using a visual analogue scale with no pain classified as 0 and worst imaginable pain as 10. For the purpose of statistical analysis a pain score of 1–3 was described as mild, 4–7 as moderate and 8–10 as severe.

In addition, the severity of ovarian adhesions was assessed as follows. Minimal adhesions were considered to be present when some (\(<1/3\)) of the surrounding structures could not be separated from the ovary with gentle pressure but the ovary could be mobilized from the majority (\(>2/3\)) of the surrounding structures. Moderate adhesions were classified when one-third to two-thirds of ovarian mobility was reduced as a result of adhesions with the surrounding structures but the structures on one-third of the surface of the ovary slid across it with the application of gentle pressure. Severe adhesions were characterized by fixed ovaries which could not be mobilized at all with gentle pressure or separated from any of the surrounding structures.

Pilot study
A pilot study was conducted on a sample of 16 women to determine the prevalence of ovarian adhesions on transvaginal ultrasound 3 months after routine laparoscopic treatment of severe pelvic endometriosis (without ovarian suspension).

Postoperatively, 11/16 women [68.8% (95% confidence interval (CI) 46.0–91.5)] had evidence of ovarian adhesions on transvaginal ultrasound. Four out of 16 (25.0% (95% CI 3.8–46.2)) women had unilateral adhesions, while 7/16 (43.8% (95% CI 19.4–68.1)) women had adhesions involving both ovaries. The adhesion rate per ovary operated on was 18/32 [56.3% (95% CI 31.9–80.6)].

Sample size
The prevalence of ovarian adhesions for each ovary from our pilot study was \(~60\%\) and this figure was used to calculate the sample size. Clinically significant improvement with ovarian suspension was defined as a 50% reduction in the prevalence of postoperative ovarian adhesion.

The software provided by Machin et al. (2009) was used to calculate the sample size for paired binary data. Assuming two-sided 5% significance, 80% power and a 54% proportion of discordant pairs, 45 women were required for the study. This calculation assumed that the response to suspension is independent of the response to non-suspension. Allowing for a possible 10% dropout during the follow-up period, we had planned to recruit at least 50 patients for the study.

Randomization
Participants were randomized to unilateral suspension of either right or left ovary. Block randomization was used with three varying block sizes of minimum size four. The randomization schedule was produced by our statistician using the external StatA command ralloc.

When a participant was recruited to the trial, consecutive randomization envelopes were opened by the anaesthetist who was not a member of the research team and the principal surgeon was told which ovary to suspend. Only the patient’s randomization number was recorded in the patient’s operation notes. A label was attached to the operation notes to define (i) the randomization number, (ii) the operation date and time and (iii) the time to remove the sutures. There was no documentation of the randomization site in the patient’s notes.

At the end of the study, the randomization was unblinded for analysis and details of the ovarian suspension were added to each participant’s record.

Ethical considerations
Approval for this study was obtained from the Medical Ethical Committees of the University College Hospital, London, UK. Each patient fulfilling the inclusion criteria was asked to sign a written informed consent. Women who refused participation were also registered.

Statistical analysis
Women with bilateral endometriosis received standard surgical treatment with the difference that, at the end of surgery, one ovary was randomized to ovarian suspension and the other to non-suspension. The primary outcome was the binary variable of the presence of ovarian adhesions 3 months after laparoscopic surgery. The outcomes were paired binary data and analyzed with the exact McNemar test. Statistical significance was set at the 5% \(\alpha\)-level. The difference between suspended and unsuspended ovaries in the percentage with adhesions was reported with 95% CIs.

The severity of ovarian adhesions was analyzed as a secondary analysis. The adhesion score was recorded for each ovary and the difference between the suspended and unsuspended ovaries was analyzed with a Wilcoxon signed rank test.

At the end of the study, an independent statistician (E.N.C.T.) analyzed the results. Statistical analysis was performed using Stata 10.1 software (StataCorp, College Station, TX, USA).

Results
Between November 2009 and June 2012, 122 premenopausal women were diagnosed with severe pelvic endometriosis on a preoperative transvaginal ultrasound scan and they were invited to join the study. A total of 67 women were excluded from randomization with the majority [15/67; 22.4% (95% CI 12.4–32.4)] excluded because they had only received partial treatment of their endometriosis, 11 [16.4% (95% CI 7.6–25.3)] women had bowel surgery, nine [13.4% (95% CI 5.3–21.6)] had ‘two-stage’ procedures, another nine did not have severe pelvic endometriosis following preoperative treatment with GnRH agonist, six [9.0% (95% CI 2.1–15.8)] declined the study, five [7.5% (95% CI 1.2–13.8)] had oophorectomies, another five had hysterectomies, four [6.0% (95% CI 0.3–11.6)] had laparotomies and three [4.5% (95% CI 0.0–9.4)] cancelled their operation, of which one [1.5% (95% CI 0.0–4.4)] woman became pregnant before surgery.

Fifty-five women fulfilled the inclusion criteria for randomization and they underwent ovarian suspension at the end of their surgery. Three women were excluded from final data analysis as they did not attend for a postoperative ultrasound scan: one became pregnant, another was lost to follow-up and the third woman suffered a large bowel injury which required a laparotomy to repair. A suspected unexpected serious adverse reaction (SUSAR) report was made to the research and ethics committee for this unexpected bowel complication. Therefore, 52 women were included in the final analysis (Fig. 1).

All 52 women were premenopausal and their mean age was 32.6 years (range 22–46). Of these, 42 [80.8% (95% CI 70.1–91.5)] women were nulliparous, three [5.8% (95% CI 0.0–12.1)] were primiparous and seven [13.5% (95% CI 4.2–22.7)] multiparous.
At presentation, 38 [73.1% (95% CI 61.0–85.1)] women were not on hormonal treatment, 6 [11.5% (95% CI 2.9–20.1)] women were using combined oral contraceptives, four [7.7% (95% CI 0.5–14.9)] women were being treated with gonadotropin-releasing hormone (GnRH) agonist, three [5.8% (95% CI 0.0–12.1)] women were using a progesterone-only pill and the remaining one [1.9% (95% CI 0.0–5.7)] woman had a Mirena intrauterine system in situ.

Prior to taking part in the trial, 21 [40.4% (95% CI 27.0–53.7)] women had one previous laparoscopic treatment for endometriosis, four [7.7% (95% CI 0.5–14.9)] had two, two [3.9% (95% CI 0.0–9.1)] had three and one [1.9% (95% CI 0.0–5.7)] woman had four previous laparoscopic surgeries.

All participants were asked about symptoms of endometriosis including dysmenorrhoea, deep dyspareunia, chronic pelvic pain and dyschezia. They were also asked about menstrual disorders and history of subfertility. One [1.9% (95% CI 0.0–5.7)] woman presented with a single symptom, six [11.5% (95% CI 2.9–20.1)] women had two symptoms, 12 [23.1% (95% CI 11.6–34.5)] women had three symptoms, 20 [38.5% (95% CI 25.2–51.7)] women had four symptoms, 12 [23.1% (95% CI 11.6–34.5)] women had five symptoms and one [1.9% (95% CI 0.0–5.7)] woman had six symptoms (Table I).

The median interval between preoperative scan assessment and ovarian suspension was 166 [interquartile range (IQR) 117–243] days. Six women [11.5% (95% CI 2.9–20.2)] required a two-stage procedure to complete their laparoscopic treatment of endometriosis. In these cases ovarian suspension was only performed following the second operation. The median interval between the first and second stage operation was 161.5 (IQR 108–229) days.

At surgery, all 52 women were found to have severe pelvic endometriosis when assessed using the revised American Fertility Society scoring and their operative findings are summarized in Table II.

Postoperative ultrasound was performed to assess ovarian mobility after surgery and ovarian suspension. The median interval between ovarian suspension and postoperative scan was 99 days (IQR 68–114).

**Primary outcome**

On examination, 38.5% (20/52) of suspended ovaries had postoperative adhesions on scan when compared with 51.9% (27/52) of unsuspended ovaries [OR 0.56 (95% CI 0.22–1.35)] (P = 0.23) (Table III).

**Secondary outcomes**

Of note, 9.6% (5/52) of suspended ovaries had moderate–severe adhesions when compared with 19.2% (10/52) of unsuspended ovaries [OR 0.38 (95% CI 0.06–1.56)] (P = 0.23) (Table IV). At the follow-up appointment, each woman was also assessed for postoperative symptoms

---

**Table I** Pre and postoperative symptoms in women (n = 52) undergoing laparoscopic surgery for endometriosis.

<table>
<thead>
<tr>
<th>Symptoms of endometriosis</th>
<th>Preoperative N (%)</th>
<th>Postoperative N (%)</th>
<th>OR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysmenorrhoea</td>
<td>39 (75.0)</td>
<td>11 (21.2)</td>
<td>0.03 (0.00–0.21)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Deep dyspareunia</td>
<td>26 (50.0)</td>
<td>7 (13.5)</td>
<td>0.10 (0.01–0.39)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dyschezia</td>
<td>30 (57.7)</td>
<td>5 (9.6)</td>
<td>0.0 (0.00–0.16)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Chronic pelvic pain</td>
<td>43 (82.7)</td>
<td>26 (50.0)</td>
<td>0.06 (0.00–0.35)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean VAS</td>
<td>5.79</td>
<td>1.98</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pain severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero (VAS = 0)</td>
<td>9 (17.3)</td>
<td>26 (50.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild (VAS 1–3)</td>
<td>7 (13.5)</td>
<td>16 (30.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate (VAS 4–7)</td>
<td>13 (25.0)</td>
<td>8 (15.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe (VAS 8–10)</td>
<td>23 (44.2)</td>
<td>2 (3.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VAS, visual analogue score; OR, odds ratio; CI, confidence interval.
Our study showed that temporary unilateral ovarian suspension for 36–48 h following surgery does not result in a significant reduction of postoperative ovarian adhesions compared with the unsuspended side. The result was the same when comparisons were made taking into account the severity of adhesions.

The study was a placebo-controlled prospective RCT which is its main strength. The patients and ultrasound operators were blinded to randomization and therefore it is unlikely that the results were influenced by bias. We opted for the within group (paired) comparisons design, which is considered to be particularly powerful and free from disadvantages which may affect quality of parallel group trials.

Discussion

Ovaries were suspended for a relatively short period of time which may be considered a weakness. We decided on the length of suspension taking into consideration the findings of animal studies which showed a reduction in adhesion formation when separation of injured peritoneal surfaces was maintained for at least 36 h (Harris et al., 1995). Another reason against longer duration of suspension was our desire to minimize the risk of complications such as small bowel strangulation. Early discharge with sutures in situ was not considered to be safe and, by limiting the length of time that the ovaries were suspended, we tried to shorten women’s postoperative in-patient stay, minimize their social disruption and avoid increasing treatment costs.

Ouahba et al. (2004) suspended 12 ovaries in eight women for 4 days following extensive surgery for severe pelvic endometriosis. They found significant ovarian adhesions in 33% of cases, which was only a slight improvement when compared with the 38% adhesions rate in our study. This indicates that longer duration of suspension may not actually lead to better surgical outcomes.

Our results are in contrast to a very small previous study which suggested a reduction in postoperative ovarian adhesions with temporary ovarian suspension (Abuzeid et al., 2002). The authors reported findings at second-look laparoscopy in five women who had ovaries suspended for 5–7 days following laparoscopic surgery for Stage 3–4 pelvic endometriosis. They found mild ovarian adhesions in one woman (20%) whilst the remaining four women were completely free of adhesions.

It is possible that the ovarian suspension procedure may be beneficial for women who have less severe endometriosis. In our study, the majority of women had unusually severe endometriosis; 43 [82.7% (95% CI 72.4–93.0)] had complete obliteration of the pouch of Douglas, eight [15.4% (95% CI 5.6–25.2)] had partial obliteration and 45 [86.5% (95% CI 77.3–95.8)] had deep infiltrating endometriosis. Temporary ovarian suspension alone may not be enough in these situations to reduce the postoperative ovarian adherence.

Only 43% of women who were found on preoperative ultrasound to have severe pelvic endometriosis were randomized for the trial. A large proportion of this was because of our strict inclusion criteria in order to ensure that all of our trial patients had similar surgical treatments prior to randomization. In our study we decided to use ultrasound rather than laparoscopy to diagnose pelvic adhesions both pre and postoperatively. Ultrasound had not been routinely used for the diagnosis of pelvic endometriosis in the past due to concerns about possible lack of sensitivity for

### Table II: Operative findings.

<table>
<thead>
<tr>
<th>Operative findings</th>
<th>N</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right endometrioma</td>
<td>25</td>
<td>48.1</td>
<td>34.5–61.7</td>
</tr>
<tr>
<td>Left endometrioma</td>
<td>24</td>
<td>46.2</td>
<td>32.6–59.7</td>
</tr>
<tr>
<td>Hydrosalpinges</td>
<td>13</td>
<td>25</td>
<td>13.2–36.8</td>
</tr>
<tr>
<td>Pouch of Douglas adhesions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None seen</td>
<td>1</td>
<td>1.9</td>
<td>0.0–5.7</td>
</tr>
<tr>
<td>Partial obliteration</td>
<td>8</td>
<td>15.4</td>
<td>5.6–25.2</td>
</tr>
<tr>
<td>Complete obliteration</td>
<td>43</td>
<td>82.7</td>
<td>72.4–93.0</td>
</tr>
<tr>
<td>Deep infiltrating endometriosis</td>
<td>45</td>
<td>86.5</td>
<td>77.3–95.8</td>
</tr>
</tbody>
</table>

### Table III: Absence of adhesions (Grade 0) versus any adhesions (Grades 1–3) by treatment type.

<table>
<thead>
<tr>
<th>Suspended ovaries</th>
<th>Unsuspended ovaries</th>
<th>None-to-mild adhesions</th>
<th>Moderate–severe adhesions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>16 (30.8%)</td>
<td>16 (30.8%)</td>
<td>32 (61.5%)</td>
<td></td>
</tr>
<tr>
<td>Adhesions</td>
<td>9 (17.3%)</td>
<td>11 (21.2%)</td>
<td>20 (38.5%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25 (48.1%)</td>
<td>27 (51.9%)</td>
<td>52 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Ovaries were suspended for a relatively short period of time which may be considered a weakness. We decided on the length of suspension taking into consideration the findings of animal studies which showed a reduction in adhesion formation when separation of injured peritoneal surfaces was maintained for at least 36 h (Harris et al., 1995). Another reason against longer duration of suspension was our desire to minimize the risk of complications such as small bowel strangulation. Early discharge with sutures in situ was not considered to be safe and, by limiting the length of time that the ovaries were suspended, we tried to shorten women’s postoperative in-patient stay, minimize their social disruption and avoid increasing treatment costs.

Ouahba et al. (2004) suspended 12 ovaries in eight women for 4 days following extensive surgery for severe pelvic endometriosis. They found significant ovarian adhesions in 33% of cases, which was only a slight improvement when compared with the 38% adhesions rate in our study. This indicates that longer duration of suspension may not actually lead to better surgical outcomes.

Our results are in contrast to a very small previous study which suggested a reduction in postoperative ovarian adhesions with temporary ovarian suspension (Abuzeid et al., 2002). The authors reported findings at second-look laparoscopy in five women who had ovaries suspended for 5–7 days following laparoscopic surgery for Stage 3–4 pelvic endometriosis. They found mild ovarian adhesions in one woman (20%) whilst the remaining four women were completely free of adhesions.

It is possible that the ovarian suspension procedure may be beneficial for women who have less severe endometriosis. In our study, the majority of women had unusually severe endometriosis; 43 [82.7% (95% CI 72.4–93.0)] had complete obliteration of the pouch of Douglas, eight [15.4% (95% CI 5.6–25.2)] had partial obliteration and 45 [86.5% (95% CI 77.3–95.8)] had deep infiltrating endometriosis. Temporary ovarian suspension alone may not be enough in these situations to reduce the postoperative ovarian adherence.

Only 43% of women who were found on preoperative ultrasound to have severe pelvic endometriosis were randomized for the trial. A large proportion of this was because of our strict inclusion criteria in order to ensure that all of our trial patients had similar surgical treatments prior to randomization. In our study we decided to use ultrasound rather than laparoscopy to diagnose pelvic adhesions both pre and postoperatively. Ultrasound had not been routinely used for the diagnosis of pelvic endometriosis in the past due to concerns about possible lack of sensitivity for...
the detection of pelvic adhesions. Recent improvement in the quality of ultrasound equipment and the examination technique showed that transvaginal ultrasound examination is an accurate and reproducible test to diagnose pelvic adhesions and to assess their severity (Holland et al., 2010, 2013; Hudelist et al., 2011). This approach enabled us to complete the trial without performing a second-look laparoscopy. The rate of postoperative adhesions in our study was comparable to the previous studies, which used second-look laparoscopy to diagnose pelvic adhesions. This finding is reassuring and it supports our view that transvaginal ultrasound is a sensitive test to diagnose pelvic adhesions.

We found a significant improvement in women’s pain scores following surgery despite the relatively high prevalence of postoperative pelvic adhesions. Although the proportion of women complaining of pelvic pain was significantly less postoperatively, half of the women continued to experience some pain which was moderate to severe in 19.3% of them. In addition, 13.5% of women continued to complain of deep dyspareunia. This occurred despite successful and complete excision of all endometriotic lesions at laparoscopy. In view of these results, it is possible that postoperative pelvic adhesions are at least partly responsible for the persistent pelvic pain following laparoscopy for endometriosis (Kresch et al., 1984; Duffy and diZerega, 1996). Postoperatively, 60% of women were taking hormonal therapy for endometriosis compared with 27% preoperatively. It is therefore possible that postoperative pain scores could have been worse if the proportion of women on hormone treatment was the same before and after surgery.

This study was powered on an anticipated adhesion proportion of 60% in the unsuspended side and 30% in the suspended side, corresponding to a 50% relative reduction. Some researchers may consider a 20% relative reduction with a 50 and 40% rate for each respective side clinically meaningful. Such a view would increase the sample size to 390 pairs. Baseline covariates that size, further analysis could be considered with conditional logistic regression models to compute adjusted odds ratios. Baseline covariates that may be considered for adjustment include age, pain severity, number of symptoms of endometriosis and observed suspension duration. Further work is required to assess the potential value of other adhesion-prevention strategies, such as surgical barrier agents, in women undergoing surgical treatment for severe pelvic endometriosis. Another study should also be considered to assess the value of temporary ovarian suspension in women having surgery for mild to moderate endometriosis.

**Conflict of interest**

E.S. received honoraria from Ethicon for provision of training to health-care professionals and consultancy fees from Bayer. A.C. is on the advisory board for surgical innovations for which he receives an annual honorarium. A.C. also received support for courses and education from Storz and Johnson and Johnson and support for clinical nursing from Covidien and Lotus. The other authors declared no competing interests.

**References**


**Authors’ roles**

All authors were responsible for the development of the study protocol. W.H. drafted the paper and had the responsibility for the logistical aspects of the trial. D.J. provided supervision and writing of the draft paper. A.S., A.C., E.S. and G.P. were responsible for the surgical treatment of endometriosis and executed the randomization instructions in theatres. E.N.C.T. was the independent statistician who analyzed the results. All authors have read and approved the final draft of this paper.

**Funding**

W.H. is supported by the research fund provided by the Gynaecology Ultrasound Centre, London UK. Trial registration: Current Controlled Trials ISRCTN24242218.
Okaro E, Condous G, Khalid A, Timmerman D, Ameye L, Huffel SV, Bourne T. The use of ultrasound-based ‘soft markers’ for the prediction of pelvic pathology in women with chronic pelvic pain—can we reduce the need for laparoscopy? BJOG 2006;113:251–256.


