A comparison of combined laparoscopic uterine artery ligation and myomectomy versus laparoscopic myomectomy in treatment of symptomatic myoma

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Objective: To evaluate the efficacy of uterine artery ligation before laparoscopic myomectomy compared with myomectomy alone.

Design: Prospective controlled, clinical trial.

Setting: Private and Shiraz University–affiliated hospitals.

Patient(s): Of 152 women with symptomatic uterine myomas necessitating surgical intervention who wished to retain their uteri, 65 underwent laparoscopic uterine artery ligation and myomectomy (experimental group) and 87 received laparoscopic myomectomy only (control group).

Intervention(s): Ligation of the uterine arteries before laparoscopic myomectomy.

Main Outcome Measure(s): Operating time, blood loss, blood transfusion, febrile morbidity, symptoms improvement, recurrence rate, and pregnancy rate.

Result(s): The average operating time and blood loss were 112 ± 18 minutes and 173 ± 91 mL for the experimental group and 95 ± 14 minutes and 402 ± 131 mL for the control group, respectively (statistically significant). A total of 15 (17.2%) of the control group patients required a blood transfusion, but none of the experimental group patients required one. Febrile morbidity occurred in 18.5% of the experimental group and 20.7% of the control group. In the experimental group, the recurrence of myoma was 6.2%, and 98.1% of the patients reported symptoms improvement; however, in the control group, these figures were 20.75% and 83.1%, respectively (statistically significant). The pregnancy rates were not statistically significantly different in the experimental group (35%) and the control group (35%).

Conclusion(s): This study demonstrated the superiority of laparoscopic uterine artery ligation combined with myomectomy in treatment of symptomatic myomas. (Fertil Steril 2009;92:742–7. ©2009 by American Society for Reproductive Medicine.)

Key Words: Laparoscopic uterine artery ligation, myomectomy, symptomatic myomas
risk of reported recurring myomas is far greater with abdominal myomectomies (1, 4) because, in cases with numerous myomas, the surgeon often removes the large and easily visible myomas, unintentionally leaving the smaller or in situ ones behind (1, 7, 8). Postoperative intact myomas within the uterus may account for a persistence of menorrhagia and a high rate of myoma recurrence. There are also controversies regarding all types of surgical intervention. Many researchers have reported that myomectomies (abdominal or laparoscopic), especially in the case of multiple myomas, have resulted in excessive blood loss, prolonged operating time, postoperative complication, and a prolonged hospital stay (7).

To address these complications, an alternative treatment, the laparoscopic bilateral coagulation of uterine vessels, was introduced by Liu in 2000 (9). Other studies reported successful outcomes in treating symptomatic myomas by uterine artery ligation that reduced the patient’s symptoms by 60% to 80% and the size of myoma by 40% to 50% (10). The exact mechanisms by which the uterine artery ligation causes the reduction in the size of myoma have not been established, yet cell apoptosis and necroses have been noted as possible explanations (1). Noting these reported benefits, laparoscopic ligation of the uterine vessels, which causes fewer complications than other procedures, may be a better alternative to hysterectomy, despite the higher technical skill required to perform this procedure (11).

We evaluated the effect of combined laparoscopic uterine artery ligation (LUAL) and myomectomy as a new therapeutic method in decreasing operative morbidities such as intraoperative hemorrhage, operation time, and postoperative fever. We also evaluated myoma recurrence and symptom alleviation associated with recurrence as well as the fertility outcomes for relevant participants. Our literature review indicates that our study comprises the highest number of patients to be observed for both the laparoscopic myomectomy group and the LUAL and myomectomy groups.

MATERIALS AND METHODS
Participants
The participants were recruited from women with symptomatic myomas during a 3-year period between 2003 and 2005. All the symptomatic myomas were diagnosed by transvaginal ultrasound or sonohysterography. All of the women wished to retain their uteri. In total, 152 women between the ages of 20 and 46 years, who could be followed up for 2 years, were selected. The women’s symptoms included menstruation problems, mostly menorrhagia and/or lower abdominal pain. None of the patients was pregnant at the time of the study nor had amenorrhea.

The patients were divided into two groups. Group one (n = 65), the experimental group, consisted of patients who underwent both LUAL and myomectomy. Group two (n = 87), the control group, included patients who were treated with laparoscopic myomectomy alone. Both groups had similar overall general characteristics including age, mean average size of myomas, and the number of myomas.

All the participants were thoroughly counseled about the potential risks, benefits, and possible fertility issues associated with uterine artery occlusion, and written informed consent was obtained from all the patients before their enrollment in the study. Institutional review board approval was obtained by the research center of Shiraz University of Medical Sciences.

Laparoscopic Techniques
Laparoscopy was performed under general anesthesia with endotracheal intubation. The participants were placed in the low lithotomy position for this procedure. A Foley catheter was inserted in the bladder and kept in place for 24 hours, and a uterine manipulator was fixed to allow uterine movement. An umbilical incision was made, and pneumoperitoneum was created with a direct trocar. Subsequently, a video laparoscope was introduced into the abdominal cavity through this port. Two 5-mm ports were placed suprapubically and medial to the right lateral umbilical ligament, and another 10-mm port was placed in left lower part of the abdomen, lateral to the lateral umbilical ligament under direct laparoscopic vision.

The peritoneum was opened in the place of ovarian fossa with scissors (a vertical incision of 2 to 3 cm). After identification of the ureter laterally and internal iliac artery medially, both were carefully separated by blunt dissection so that the uterine artery could be seen originating from the internal iliac artery crossing over the ureter. The uterine arteries were ligated bilaterally with silk 0 sutures. The peritoneal window was closed with Vicryl 3-0.

When the uterine arteries had been successfully occluded, a linear or elliptic incision was performed over the myoma with a hook tip monopolar cautery, and the incision was carried through the superficial myometrium directly into the underlying myoma. The myoma was fixed with a screw, and enucleation was completed with the aid of two forceps. After that, only the main bleeders in the myoma’s bed were coagulated with bipolar forceps.

Myometrium was repaired in two or three layers via a continuous Vicryl 1-0, and the serosal edge of the uterine incision was carefully approximated with a continuous Vicryl 4-0 baseball stitch. Electromechanical morcellation for removal of myomas (Storz, Tuttingen, Germany) was used through the left lateral port.

The pelvic lavage was carried out with normal saline solution before the application of an Interceed barrier (Ethicon, Johnson & Johnson, Neuchatel, Switzerland). Blood loss was estimated by subtracting the rinsing volume from the blood volume that was collected in the suction.

No complications occurred during laparoscopic myomectomy, morcellation, or LUAL procedures.

Postoperative Follow-up
For a period of 24 months, all of the patients were evaluated every 3 months to assess their symptoms and check for the
recurrence of myomas by transvaginal ultrasound. Patients graded their subjective symptomatic changes in terms of pain and bleeding using one of two choices: completely resolved or unchanged. Menorrhagia improvement was evaluated by the pads used during menstruation, and dysmenorrhea improvement was evaluated by the amount of analgesics used.

The recurrence of myoma in this study was defined as the presence of a myoma of at least 2 cm in diameter. Symptoms resolution was defined as a state where none of previous symptoms was reported. Furthermore, for the infertile patients, the number of women who became pregnant after the operation and the outcome of those pregnancies such as spontaneous abortions or live births were recorded. If pregnancy did not occur spontaneously in the first 12 months after the operation, another method such as intrauterine insemination or in vitro fertilization (IVF) was performed for the patient.

**Statistical Analysis**

The data are presented as mean and standard deviation. Parametric independent samples t-test was used to compare differences between the two groups, and categorical variables were analyzed by chi-square test. P<.05 was considered statistically significant.

### RESULTS

In total, 152 women in both groups completed the 24 months of follow-up. The number of patients in the experimental group was 65 and in the control group was 87. There were no major complications during any of the surgeries.

Table 1 shows the demographic and clinical characteristics of the patients in the two groups. There were no statistically significant differences in the mean age of the patients, or the average size and number of the myomas between the experimental and the control groups. Infertility was the chief complaint for 14 (21.5%) patients in the experimental group and 20 (23%) in the control group.

Table 2 shows that the average blood loss and the average operating time were statistically significantly different between the two groups (P=.0001). A further 17 additional minutes were required to complete the LUAL procedure, but this additional time resulted in a statistically significant decrease in blood loss in the experimental group. In addition, in the control group 15 patients (17.2%) required blood transfusions during or after the surgery; in contrast, none of the patients in the experimental group needed blood transfusions (P<.00036). So the experimental procedure not only achieved an effective hemostasis during myomectomy but also prevented the eventual blood transfusion side effects;

### TABLE 1

Demographic and clinical characteristics of patients.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years)</th>
<th>Number of myomas</th>
<th>Size of myomas (cm)</th>
<th>Women with infertility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32.90 ± 6.20 (21–46)</td>
<td>2.20 ± 1.10 (1–6)</td>
<td>6.12 ± 1.29 (4.2–9.5)</td>
<td>23 (20/87)</td>
</tr>
<tr>
<td>2</td>
<td>33.51 ± 6.75 (20–46)</td>
<td>2.32 ± 1.35 (1–7)</td>
<td>5.91 ± 1.41 (4.0–9.3)</td>
<td>21.5 (14/65)</td>
</tr>
<tr>
<td>P value</td>
<td>.563</td>
<td>.533</td>
<td>.332</td>
<td>.832</td>
</tr>
</tbody>
</table>

Notes: Group 1: myomectomy only (n = 87). Group 2: laparoscopic uterine artery ligation (LUAL) plus myomectomy (n = 65). P<.05 was considered statistically significant.


### TABLE 2

Surgical data and short-term follow-up results.

<table>
<thead>
<tr>
<th>Group</th>
<th>Operation time (min)</th>
<th>Blood loss (mL)</th>
<th>Febrile morbidity</th>
<th>Postoperative hospital stay (days)</th>
<th>Need for blood transfusion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95.52 ± 14.27 (70–130)</td>
<td>402.87 ± 131.57 (200–900)</td>
<td>18 (20.7%)</td>
<td>2.25 ± 0.73 (1–4)</td>
<td>17.2 (15/87)</td>
</tr>
<tr>
<td>2</td>
<td>112.54 ± 18.88 (80–160)</td>
<td>173.62 ± 91.47 (50–400)</td>
<td>12 (18.5%)</td>
<td>2.05 ± 0.62 (1–4)</td>
<td>0</td>
</tr>
<tr>
<td>P value</td>
<td>.0001</td>
<td>.0001</td>
<td>.733</td>
<td>.069</td>
<td>.00036</td>
</tr>
</tbody>
</table>

Notes: Group 1: myomectomy only (n = 87). Group 2: laparoscopic uterine artery ligation (LUAL) plus myomectomy (n = 65). P<.05 was considered statistically significant. Results reported as mean ± standard deviation (range) unless noted. Febrile morbidity = temperature ≥ 38°C.

these benefits justify 17 minutes of additional operating time.

Febrile morbidity occurred in 12 patients (18.5%) in the experimental group and 18 patients (20.7%) in the control group, which was not statistically significant \((P = .733)\). The average length of the postoperative hospital stay was also similar in both the control and experimental groups \((P = .069)\).

Table 3 shows that the symptom recovered much better in the LUAL, myomectomy group versus the laparoscopic myomectomy group \((P = .007)\). The recurrence rate of myomas in the control group, who had only laparoscopic myomectomy, was higher than that in the experimental group that received both treatments \((P = .012)\). Furthermore, in the infertile patients 4 out of 14 (28.5%) in the experimental group and 6 out of 20 (30%) in the control group had a live birth and one patient aborted her fetus in each group which was not statistically significant.

**DISCUSSION**

Our study evaluated the efficacy of combined LUAL and myomectomy to alleviate intraoperative morbidity, to decrease the chance of myoma recurrence, and to improve myoma-related symptoms. The concept of uterine vessels ligation had already been described by Liu et al. (4, 7); the main difference in our method compared with previous studies was that we approached the uterine vessels from the ovarian fossa. As far as we are aware, our study comprised the largest number of patients to have undergone LUAL and laparoscopic myomectomy versus laparoscopic myomectomy alone. Previously, the largest study had been the 46 cases in the laparoscopic myomectomy alone and 56 cases in laparoscopic uterine depletion procedure plus myomectomy group in the study by Liu et al. (7).

Although hysterectomy is the most certain, most conventional cure for women with symptomatic myomas who do not wish to retain childbearing potential, a large number of women are choosing organ-conserving surgeries such as myomectomy, LUAL, and myolysis as alternatives. Myomectomy gives women a chance to retain their uteri, but it is difficult to perform, and the surgical complications such as bleeding, postoperative fever, and adhesions are more common than with hysterectomy (1, 7, 12).

Until now, different methods have been designed to decrease intraoperative bleeding during myomectomy. One of them was a special clamp to compress the uterine and ovarian arteries (13), and another was rubber-shod sponge forceps for occlusion of the uterine and ovarian arteries (14). Another study reported that using a catheter to encircle the lower uterine segment could occlude the uterine vessels (15). These studies recommended releasing the compression approximately every 10 to 20 minutes to prevent ischemic necrosis in the myometrium. In 2000, Liu (9) described a new method, called laparoscopic bipolar coagulation of uterine vessels (LBCUV). In that method, both uterine arteries as well as the anastomosis zone of the uterine and ovarian arteries were occluded. As a result, the ligation of the uterine arteries before myomectomy became a useful homeostasis procedure.

Our technique involved ligation of the uterine arteries with silk sutures before the laparoscopic myomectomy. This procedure contributed to a mean blood loss of 173.62 ± 91.47 mL from LUAL and myomectomy, which was statistically significantly less than the 402.87 ± 131.57 mL loss from laparoscopic myomectomy alone \((P < .0001)\).

The decrease in blood loss was due to the uterine artery ligation, similar to the bipolar coagulation of the uterine artery as described by Liu et al. (4, 9, 16). We did not use vasopressin so that we could see the sole effect of LUAL, which may explain the higher than average blood loss in both groups compared with other reports (1, 7). Although blood transfusion was required in 17.2% of those in the control group, none of the patients in the experimental group required it. In another study, 13.3% of the patients in a myomectomy only group needed blood transfusion, but none of the uterine artery occlusion plus myomectomy group patients required one (1). As a result, uterine artery occlusion has been shown to achieve an effective hemostasis technique before laparoscopic myomectomy.

A further 17 additional minutes were required to complete the uterine artery occlusion procedure in our study. This is comparable with the average time of 13 minutes reported by other studies (6). This additional time resulted in

**TABLE 3**

<table>
<thead>
<tr>
<th>Group</th>
<th>Symptom resolution (%)</th>
<th>Recurrence rate (%)</th>
<th>Pregnancy rate (%)</th>
<th>Live birth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83.1 (59/71)</td>
<td>20.7 (18/87)</td>
<td>35.7 (7/20)</td>
<td>30 (6/20)</td>
</tr>
<tr>
<td>2</td>
<td>98.1 (52/53)</td>
<td>6.2 (4/65)</td>
<td>35 (5/14)</td>
<td>28.5 (4/14)</td>
</tr>
<tr>
<td>(P) value</td>
<td>.007</td>
<td>.012</td>
<td>.966</td>
<td>.63</td>
</tr>
</tbody>
</table>

*Notes: Group 1: myomectomy only \(n = 87; 20\) women with infertility. Group 2: laparoscopic uterine artery ligation (LUAL) and myomectomy \(n = 65; 14\) women with infertility. \(P < .05\) was considered statistically significant.*

a significant decrease in the intraoperative hemorrhage and no need for blood transfusions in the LUAL plus myomectomy group. We ligated the uterine arteries by the ovarian fossa approach after dissection of the ureters and closed the peritoneal window after uterine artery ligation. The learning curve for laparoscopic ligation of uterine arteries might be longer for inexperienced surgeons.

Postoperative fever in our study involved 18.5% and 20.7% of the patients in the experimental group and the control groups, respectively, which was not statistically significant. This rate was similar to that reported by another study (1). The main cause of postoperative fever may have been remaining blood clots in the abdomen or hematoma formation in the myometrium. Uterine artery ligation may have been useful in decreasing oozing from the uterus and indirectly reduced the postoperative fever, but we did not see a statistically significant difference in the rate of postoperative fever between the two groups.

The main symptom of myomas is menorrhagia, and in our study 98% in the experimental group and 83% in control group experienced resolution of this symptom after surgery (P=.007). Thus, menorrhagia seems to respond favorably to the LUAL procedure, and this phenomenon was also noted in other studies (7, 12, 17, 18). This finding seems to be due to partial uterine ischemia and necrosis of the small myomas that were left at the time of surgery.

The main underlying cause for treatment failure has been the presence of multiple myomas (1, 11). Large, easily visible myomas are removed, but a tendency exists to leave small myomas and concealed myomas in the submucosal area (1, 7, 11). Thus, leaving small concealed myomas in the uterus could explain the treatment failure and the persistence of menorrhagia postoperatively. The occlusion of the uterine artery can destroy some symptomatic myomas in the uterus, thus effectively treating small symptomatic myomas growing in the uterus in future (1). In our study, all large, visible myomas were removed by laparoscopic myomectomy, and the small ones were treated by uterine artery ligation (LUAL), resulting in a 6.2% recurrence rate in the experimental group, which was far lower than the 20.7% observed in the control group. In other studies, the success rate was 67.3% to 84.0% in the myomectomy group and 94.2% to 100.0% in uterine-depletion group (1, 7).

Uterine artery occlusion appears to be a reliable procedure. Of 157 women who were treated with uterine artery embolization, none had symptomatic myomas during the average 30-month follow-up period (19). The procedure seems to treat the symptoms associated with myomas completely. The ligation of the uterine arteries may be causing an ischemic change and necrosis in small myomas that would grow in the future (17).

One of the most important issues in relation to LUAL or other methods of uterine artery occlusion is the adequacy of the approach for women who wish to become pregnant. Successful pregnancies have been reported in the literature after occlusion of both internal iliac and ovarian arteries (20). After bilateral uterine artery ligation, 12 successful pregnancies were reported after cesarean section (21). Another study reported a 14.6% pregnancy rate after bilateral occlusion of the uterine vessels, but only 5.6% of these pregnancies resulted in a live birth (22). In theory, uterine vascular depletion and endometrial insufficiency could result from laparoscopic bipolar coagulation of uterine vessels or uterine artery embolization (17). Between 19.2% and 59.2% of the women without infertility who underwent uterine artery ligation plus myomectomy were reported to have become pregnant (1, 7). The pregnancy rate after laparoscopic myomectomy in infertile patients was reported to be between 53.6% and 64.3% after a lengthy period of follow-up (23, 24).

In our study groups, the pregnancy rate was 35.7% in the experimental group and 35% in the control group (not statistically significant). We ligated only the uterine arteries before myomectomy, which might explain why the pregnancy rate was not statistically significantly different between the two groups. We did not ligate the anastomotic sites of the uterine arteries and the ovarian arteries, and we did not block the blood supply to the ovaries from the infundibulopelvic ligament, which made the procedure’s impact on ovary function minimal. However, fertility and pregnancy-related complications after LUAL and myomectomy still need more study.

Among the infertile patients in our groups, 30% of the infertile women in the experimental group and 28.5% in the control group had a live birth. Other studies had reported about 50% for a myomectomy-only group, and 37.5% in a uterine-depletion and myomectomy procedures group had a live birth, but their patients were not infertile and only wanted a pregnancy (7). A live birth rate of 35.7% to 50% was reported after laparoscopic myomectomy in infertile patients after a longer follow-up duration (23, 24).

Our study revealed that uterine artery ligation and myomectomy by laparoscopy might be an effective treatment alternative for those women who have symptomatic myomas and wish to preserve their fertility. The benefits of this method were a decrease in the chance of intraoperative bleeding and in recurrence of myomas and a nearly complete resolution of symptoms with no adverse effect on fertility when compared with laparoscopic myomectomy. More studies with a larger number of infertile patients are needed to address the possible effect of this procedure on fertility outcomes.

REFERENCES