**Pregnancy following treatment of symptomatic myomas with laparoscopic bipolar coagulation of uterine vessels**

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**BACKGROUND:** Laparoscopic bipolar coagulation of uterine vessels (LBCUV) has been employed for women with symptomatic uterine myomas, but its effect on subsequent pregnancy has not been characterized. METHODS: Four-hundred and twenty-three women entered the study between March 1999 and December 2001. Of these, 142 women (33.6%) were under the age of 40 years at the time of LBCUV, 36 of whom (36/142, 25.3%) were sexually active without contraception. In a prospective study of 142 patients (<40 years old) undergoing LBCUV for symptomatic myomas, 15 women became pregnant (17 total pregnancies) and were evaluated by physical and ultrasound examinations. RESULTS: The volume of the dominant myoma was 117.4 ± 118.4 and 36.8 ± 56.8 cm³ before and after LBCUV respectively. Volume of the dominant myoma after pregnancy was 46.2 ± 76.7 cm³ (mean ± SD). There was a significant difference in myoma volume before and after LBCUV (P = 0.002), but no significant difference in myoma volume when comparing post-partum size with post-LBCUV size (P = 0.269). Pregnancy outcomes included seven miscarriages in the first trimester and one premature rupture of membrane (PPROM). Although the other pregnancies were regarded as uncomplicated, only two women were delivered of normal neonates as the other seven pregnancies were terminated secondary to patient request. CONCLUSIONS: The pregnancy and term pregnancy rates in sexually active women without contraception were 41.6% (15/36) and 5.6% (2/36) respectively. Because a relatively high rate (7/17, 41.2%) of early miscarriages was observed, we recommend that this procedure be employed only for women who do not desire additional children.

**Key words:** laparoscopic bipolar coagulation of uterine vessels/laparoscopic surgery/pregnancy/myoma

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**Introduction**

Bilateral uterine artery embolization (UAE) was introduced for the management of uterine myomas in 1995 (Ravina et al., 1995). A similar approach, using uterine vessel depletion by laparoscopic bipolar coagulation of uterine vessels (LBCUV), has been utilized in our department for the past 3 years (Liu, 2000; Liu et al., 2001a; Wang et al., 2001; Yen et al., 2001). The procedure is effective in managing uterine myomas (Liu, 2000; Liu et al., 2001a; Yen et al., 2001), but data regarding subsequent fecundity and pregnancy outcomes are lacking. In contrast, sporadic case reports describing viable intrauterine pregnancy following UAE have been documented (Ravina et al., 2000). We previously described one pregnancy with delivery of a normal fetus (Chen et al., 2002a) and another pregnancy that was terminated at the patient’s request at 10 weeks gestation (Chen et al., 2002b) following LBCUV, and proposed that the procedure may not affect subsequent reproductive function (Chen et al., 2002a; b). In the present study, we evaluated the incidence and outcomes of post-LBCUV pregnancies.

**Materials and methods**

By the end of 2001, 423 patients had been enrolled in a prospective study to evaluate long-term outcomes of LBCUV for symptomatic myomas. All patients indicated that they did not intend future pregnancies. Of these, 142 women (33.6%) were under the age of 40 years at the time of LBCUV, 36 of whom (36/142, 25.3%) were sexually active without contraception. The study was approved by the ethics committee of the Department of Obstetrics and Gynecology, Taipei Veterans General Hospital, and written informed consent was obtained from all patients enrolled in the study. Fifteen patients experienced unexpected pregnancies, and the course and outcome of these pregnancies were studied.

Procedural techniques for LBCUV have been described previously (Liu, 2000; Liu et al., 2001a). With a laparoscope and video camera in place, a vertical incision (3 cm) was made on a triangular area defined by the round ligament, external iliac artery and infundibulopelvic...
ligament. With the aid of the grasper compressing the ureter medially, the uterine artery was isolated from the ureter and the internal iliac artery. The uterine artery was then thoroughly desiccated using Kleppinger bipolar forceps (Richard Wolf, IL, USA) under direct visualization with the laparoscope, and the bilateral uterine arteries were double-ligated with haemoclips. The anastomotic sites of the uterine arteries and the ovarian arteries were also coagulated using bipolar forceps without producing thermal injury to the ovary and the Fallopian tube. The patients were discharged on post-operative day 2.

Ultrasound examination was performed to determine the size of the uterus and the dominant myoma. Uterine volume and the dominant myoma were calculated using the formula: length × width × anterior–posterior thickness × 0.52, as an approximation of the volume of prelate ellipsoid (Goldstein et al., 1998; Wang et al., 1998; Lee et al., 1999). All patients underwent repeat ultrasound 3 months post-operatively.

Characteristics of 15 patients diagnosed with pregnancy were recorded. Obstetric routines and changes in the myomas were assessed by monthly physical and ultrasound examinations. Information regarding fetal growth, feto-maternal vasculation (uterine arteries, umbilical cord and fetal cerebral arteries) and uterine myoma was recorded. Obstetric routines and changes in the myomas were assessed by coloured Doppler ultrasound and B scan ultrasound. Age regarding fetal growth, feto-maternal vasculation (uterine arteries, umbilical cord and fetal cerebral arteries) and uterine myoma was assessed by coloured Doppler ultrasound and B scan ultrasound. Age and term at pregnancy outcome were noted for each patient, with special attention to miscarriages or premature births. At delivery, all patients were monitored for uterine contractions, fetal heart rate, duration of labour, and abnormal bleeding (during labour and postpartum). Delivery mode, birth weight, and postpartum course of the mother and infant were also assessed.

$P$ values were calculated using the paired $t$-test. $P$ values <0.05 were considered statistically significant.

**Results**

Patient characteristics are summarized in Table I. A total of 15 women became pregnant during the post-operative follow-up, two of whom became pregnant twice, making a total of 17 pregnancies. The dominant myoma in all 15 patients was intramural type. The myoma was located in the posterior wall in four patients (26.7%), the posterior fundus in three patients (20%), the fundus in three patients (20%), the anterior wall in three patients (20%), the anterior fundus in one patient (7%), and the left wall in one patient (7%). All patients presented with symptomatic myomas.

Resolution of menorrhagia was assessed by counting the number of sanitary pads needed during menstruation, while resolution of dysmenorrhea was assessed by the amount of analgesics required (Liu et al., 2001a, b). Thirteen patients (13/15, 86.7%) reported that their symptoms (menorrhagia or dysmenorrhea) improved post-operatively. When analysed by symptom type, 12 of 13 patients (92.3%) with menorrhagia and 7 of 9 patients (77.7%) with dysmenorrhea improved post-operatively.

Uterine volume before LBCUV ranged from 149 to 519.3 cm$^3$, with a mean of 312.0 cm$^3$ and a median of 313.8 cm$^3$. Uterine volume after LBCUV ranged from 75 to 405 cm$^3$, with a mean of 143.4 cm$^3$ and a median of 118.9 cm$^3$. Volume of the dominant myoma was 117.4 ± 118.4 cm$^3$ (mean ± SD) and 36.8 ± 56.8 cm$^3$ before and after LBCUV respectively. Volume of the dominant myoma after pregnancy was 46.2 ± 76.7 cm$^3$. These means included the dominant myoma, where more than one was present. There was a significant difference in myoma volume before and after LBCUV ($P = 0.002$), but no significant difference in myoma volume when comparing postpartum size with post-LBCUV size ($P = 0.026$, non-significant). Eleven women (patients 1, 3, 6, 7, 8, 9, 10, 12, 13, 14, 15) were diagnosed with single myomas, while the other patients had multiple myomas.

The pregnancy and term pregnancy rates in women who were sexually active without contraception were 41.6% (15/36) and 5.6% (2/36). Patient age at LBCUV ranged from 31–40

### Table I. Data on uterine depletion and subsequent pregnancies

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Patient no.</th>
<th>Age (years)</th>
<th>Myoma volume (cm$^3$)</th>
<th>Location</th>
<th>Myoma volume (cm$^3$)</th>
<th>Delay (months)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>38</td>
<td>65</td>
<td>Posterior-fundal</td>
<td>1</td>
<td>1078</td>
<td>33.5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>38</td>
<td>52</td>
<td>Anterior</td>
<td>2</td>
<td>15.6</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>37</td>
<td>50</td>
<td>Left wall</td>
<td>1</td>
<td>42.3</td>
<td>38.7</td>
</tr>
<tr>
<td>4, 5</td>
<td>4</td>
<td>40</td>
<td>41.6</td>
<td>Anterior</td>
<td>3</td>
<td>9.7</td>
<td>11.1</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>40</td>
<td>42.1</td>
<td>Fundal</td>
<td>3</td>
<td>1.9</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>39</td>
<td>130.2</td>
<td>Fundal</td>
<td>1</td>
<td>112.3</td>
<td>234</td>
</tr>
<tr>
<td>8, 9</td>
<td>7</td>
<td>39</td>
<td>493.1</td>
<td>Fundal</td>
<td>1</td>
<td>215</td>
<td>230</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>33</td>
<td>129</td>
<td>Posterior</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>9</td>
<td>39</td>
<td>55.8</td>
<td>Posterior-fundal</td>
<td>1</td>
<td>16.7</td>
<td>18.2</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>39</td>
<td>59.8</td>
<td>Posterior-fundal</td>
<td>1</td>
<td>10.2</td>
<td>8.9</td>
</tr>
<tr>
<td>13</td>
<td>11</td>
<td>34</td>
<td>255.1</td>
<td>Anterior-fundal</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>36</td>
<td>149</td>
<td>Posterior</td>
<td>1</td>
<td>38.5</td>
<td>41.3</td>
</tr>
<tr>
<td>15</td>
<td>13</td>
<td>31</td>
<td>69</td>
<td>Posterior</td>
<td>1</td>
<td>2.8</td>
<td>2.1</td>
</tr>
<tr>
<td>16</td>
<td>14</td>
<td>39</td>
<td>97.7</td>
<td>Anterior</td>
<td>1</td>
<td>29.3</td>
<td>25.7</td>
</tr>
<tr>
<td>17</td>
<td>15</td>
<td>39</td>
<td>71.8</td>
<td>Posterior</td>
<td>1</td>
<td>22.3</td>
<td>30.3</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>37.4</td>
<td>117.4</td>
<td>1.5</td>
<td>36.8</td>
<td>46.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Median</td>
<td></td>
<td>39</td>
<td>69.0</td>
<td>1.5</td>
<td>16.7</td>
<td>18.2</td>
<td>4</td>
</tr>
</tbody>
</table>

*P = 0.02, myoma volume before LBCUV versus myoma volume after LBCUV. FHB = fetal heart beat.
years, with a mean of 37.4 years and a median of 39 years. The duration between the LBCUV and the beginning of the first pregnancy ranged from 0–22 months, with a mean of 6.5 months and a median of 4 months. Patient age at pregnancy ranged from 32–42 years, with a mean of 37.4 years and a median of 39 years.

Seven women experienced miscarriage between 6 and 11 weeks gestation. A relatively high rate (7/17, 41.2%) of early miscarriages was observed. One woman experienced premature preterm rupture of membrane (PPROM) at 19 weeks gestation. Other patients had normal ultrasound findings, including active fetal heart beat, normal fetal growth (as determined by crown–rump length), normal gestational sac morphology and normal amounts of amniotic fluid. However, only two women brought the pregnancy to term; other pregnancies were terminated per patient request. All patients received regular prenatal counselling and follow-up without complication.

Of the two term pregnancies, one was delivered vaginally and the other was delivered via Cesarean section secondary to previous history of Cesarean section delivery. Both women had normal pre-, during and post-labour course. Uterine rupture did not occur in this study.

Discussion

Several investigators report successful pregnancy outcomes following UAE-managed myomas (Bradley et al., 1998; Hutchins et al., 1999; Nicholson and Ettles, 1999; Pron et al., 1999; Ravina et al., 2000; McLucas et al., 2001; Pelage and Walker, 2002) (Table II). In a study by McLucas et al. (2001), 139 of 400 patients that underwent embolization therapy for uterine myomas stated a desire for fertility, with 52 of the 139 patients <40 years old and 10 term deliveries. Subsequently, 17 pregnancies were reported in 14 women, and 10 term deliveries occurred. Pregnancy and term pregnancy rates were 33 and 19% respectively. Another series described six term deliveries following embolization therapy in 122 women >40 years of age. Twenty-four patients were sexually active without contraception. Pregnancy and term pregnancy rates were 38 and 25% respectively (Pelage and Walker, 2002). In our study, the pregnancy and term pregnancy rates in sexually active women without contraception were 41.6% (15/36) and 5.6% (2/36) respectively. Because a relatively high rate of D&C (7/17, 41.2%) was observed, the term pregnancy rate in the current study was lower than that reported by other investigators (McLucas et al., 2001; Pelage and Walker, 2002).

In this study, a relatively high rate (7/17, 41.2%) of early miscarriages was observed, similar to the 41.7% (5/12) rate reported previously (Ravina et al., 2000). However, confounding factors, such as parity, maternal/paternal age and uterine condition, may complicate interpretation of these results. While the frequency of clinically recognized abortion increases from 12% in women <20 years old to 26% in those >40 years (Wilson et al., 1986), the contribution of uterine myoma to early miscarriage is not clear. Rice and associates reported that myomas >3 cm in size are associated with preterm labour, placental abruption, pelvic pain and Cesarean delivery (Rice et al., 1989), but the rate of miscarriage with myoma was still similar to the age-adjusted general population (Winer-Muran et al., 1984). In the present study, mean age at pregnancy was 37.4 years, but the rate of miscarriage was higher than the oldest cohort of the general population. Anatomical considerations may explain this increased rate of miscarriage (Winer-Muran et al., 1984), as implantation adjacent to the myoma site may be present.

Several studies using uterine artery Doppler evaluation demonstrated increased uterine impedance with lower pregnancy rates in IVF embryo transfer (Cacciatore et al., 1996; Zaidi et al., 1996; Yang et al., 1999). However, early pregnancy is unlikely to be affected by small changes in perfusion because early placentation occurs in a hypoxic

### Table II. Pregnancy outcome after uterine artery embolization and LBCUV

<table>
<thead>
<tr>
<th>Investigator, date</th>
<th>Procedure</th>
<th>No. of patients</th>
<th>No. of pregnancies</th>
<th>No. of deliveries</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradley et al., 1998</td>
<td>UAE</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>First-trimester viability confirmed 1 term delivery, 1 case of IVF twins, ongoing first trimester Regrowth of myoma during pregnancy</td>
</tr>
<tr>
<td>Hutchins et al., 1999</td>
<td>UAE</td>
<td>305</td>
<td>2</td>
<td>1</td>
<td>Regrowth of myoma during pregnancy, term Caesarean section</td>
</tr>
<tr>
<td>Pron et al., 1999</td>
<td>UAE</td>
<td>77</td>
<td>1</td>
<td>7</td>
<td>5 first-trimester losses 7 births: 3 preterm, 4 term</td>
</tr>
<tr>
<td>Nicholson and Ettles, 1999</td>
<td>UAE</td>
<td>24</td>
<td>1</td>
<td>1</td>
<td>24 patients &lt;40 years old, who were sexually active without contraception. Pregnancy rate 38%</td>
</tr>
<tr>
<td>Ravina et al., 2000</td>
<td>UAE</td>
<td>184</td>
<td>12</td>
<td>7</td>
<td>6 term pregnancies 1 ongoing pregnancy 1 ectopic pregnancy 2 miscarriages 52 patients &lt;40 years old, who were sexually active without contraception. Pregnancy rate 33%</td>
</tr>
<tr>
<td>Pelage and Walker, 2002</td>
<td>UAE</td>
<td>122</td>
<td>10</td>
<td>6</td>
<td>10 term pregnancies 2 ongoing pregnancies</td>
</tr>
<tr>
<td>McLucas et al., 2001</td>
<td>UAE</td>
<td>139</td>
<td>17</td>
<td>10</td>
<td>36 patients &lt;40 years old, who were sexually active without contraception. Pregnancy rate 41.6%</td>
</tr>
<tr>
<td>Chen et al., 2002</td>
<td>LBCUV</td>
<td>142</td>
<td>17</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

*Current report.*
milieu, with plugging of the spiral arteries by endotrophoblastic cells (Jauniaux et al., 1994). While data concerning the relationship between miscarriage and uterine artery perfusion are conflicting, anecdotal observations by Ravina’s group (Ravina et al., 2000) and our group were consistent with increasing rates of miscarriage and failed implantation.

In theory, uterine vascular depletion and endometrial insufficiency could result following UAE, but the low frequency of pregnancy following this procedure has hampered investigation of possible growth restriction. One report described a small-for-gestational-age infant following bilateral ligation of the internal iliac arteries (Morikawa and Takamizawa, 1986). However, there were three women who bore term infants successfully after bilateral ligation of internal iliac arteries and ovarian arteries (Mengert et al., 1969), with similar results described by another group (Shinagawa et al., 1981). Thus, even after bilateral ligation of both the internal iliac and ovarian arteries, there was sufficient pelvic blood supply to support and provide normal development of a term-size child (Mengert et al., 1969). Uterine myomas appear to be particularly sensitive to the effects of the acute ischaemia produced by embolization, but collateral circulation may contribute to preservation of uterine integrity. While revascularization could prove successful in the normal myometrium, it could not be employed in the case of myomas (Lumsden et al., 2002). These phenomena are consistent with the successful term pregnancy described in the present study. Therefore, LBCUV itself may not contribute to compromised placental function, but, rather, early pregnancy may be affected by occult small changes in uterine perfusion and endometrial sufficiency.

Lev-Toaff and co-workers demonstrated that 47.1% of myomas did not change in size during the first trimester, while 52.9% increased in size (Lev-Toaff et al., 1987). In contrast, only one case (6.7%) in our study had an increase in myoma size during pregnancy, and the myoma size subsequently normalized following pregnancy. Furthermore, no recurrence of myoma in pregnancy was observed in 12 cases following embolization in Ravina’s series. Thus, it appears that pregnancy has no bearing on the effectiveness of the LBCUV or UAE in managing uterine myomas.

In two patients, no myoma was found after therapy, although one patient had a very large myoma (255 cm³; Table I). Disappearance of myoma after LBCUV is possible. In our previous study, the average myoma volume reduction was 76% (range 38–100), with the most notable reduction being the disappearance of an 11 cm myoma (Liu et al., 2001a). Another possibility is that myoma size after LBCUV is below the threshold of ultrasound detection. Indeed, there is a myomas false-negative rate of up to 20% with sonography (Gross et al., 1983). Sonographic limitations include uterine orientation (e.g. retroflexed uterus), concurrent uterine or adnexal abnormalities, and small tumour size (Baltarowich et al., 1988; Strobelt et al., 1994).

Uterine artery embolization may not be an ideal approach when symptoms can be attributed to a submucosal myoma. Some cases of ostensibly successful treatment of submucosal myoma with this procedure may actually be secondary to spontaneous amputation following embolization or LBCUV (Berkowitz et al., 1999; Liu et al., 2001b). However, studies have clearly described complications when this procedure has been employed for submucosal myomas (Vashisht et al., 1999; Liu et al., 2001b), or they have simply stated that it was ineffective (Hurst et al., 2000). In our experience, nine women with submucosal myomas experienced vaginal expulsion of myomas after LBCUV, but four women (44.4%) were readmitted with complications (Liu et al., 2001b). Because submucosal myomas pose a high risk of infection, hysteroscopic resection should be considered the preferable approach (Hurst et al., 2000). Furthermore, we prefer myomectomy to LBCUV for patients with subserosal myomas.

The current study is the first series to document pregnancy following LBCUV. Definitive data regarding pregnancy following UAE or LBCUV are still required to form comprehensive guidelines on the use of UAE or LBCUV versus myomectomy, and, thus, LBCUV should only be employed in patients who do not desire further pregnancies.

In conclusion, LBCUV for the management of myomas is a less invasive procedure that preserves the uterus and possibly maintains future reproductive capacity. This study reaffirmed previous observations that LBCUV is a safe and effective alternative to myomectomy and hysterectomy. Larger studies to investigate post-LBCUV fecundity and pregnancy-related complications (including IUGR) would be of benefit.

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Pregnancy following laparoscopic bipolar coagulation of uterine vessels