A national survey of the complications of endometrial destruction for menstrual disorders: the MISTLETOE study

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Objectives
To study the frequency of complications of endometrial resection and ablation for menstrual disturbances and the influence of the experience of the operators.

Design
Prospective survey with additional retrospective reporting by theatre staff.

Setting
300 National Health Service and independent hospitals in the United Kingdom (excluding Scotland).

Population
10,686 women registered by 690 doctors (1–222 cases/doctor) from April 1993 to October 1994.

Methods
Mailings were sent to relevant medical and non-medical staff at every hospital to ascertain who performed the operations. These doctors were asked to complete a questionnaire detailing their previous experience. Completed patient registration forms were returned each month. Theatre contacts returned lists of cases reported in theatre registers.

Main outcome measures
Perioperative, post-operative and delayed complications by method of surgery and experience of operator.

Results
Two directly related deaths were reported. Laser and rollerball ablations were associated with least operative and post-operative complications. Combined loop and rollerball diathermy was associated with a higher rate, but with fewer immediate operative complications than loop resection alone. Endometrial thinning agents were not associated with decreased complications. Fibroids were associated with increased operative haemorrhage. Early post-operative complication rates ranged from 0.77% to 1.51%. Six-week follow up in 82.5% of the women revealed few complications (1.25% to 4.58%). Increasing operative experience was associated with fewer uterine perforations in the loop resection alone group ($\chi^2$ for trend, $P < 0.001$), but had no effect on operative haemorrhage in any group.

Conclusions
These procedures were used widely in 1993 to 1994 with low morbidity and mortality. The techniques may be relatively easily learned in the apprenticeship system without compromising safety. Combined diathermy resection appears safer than loop resection alone, but laser and rollerball ablation were safest.

INTRODUCTION
The techniques of endometrial ablation and resection were introduced to the United Kingdom in the mid-1980s. They gained popularity because of their ability to treat menstrual bleeding problems successfully without the need for hysterectomy. A survey by the Audit Unit of the Royal College of Obstetricians and Gynaecologists in mid-1991 showed that 56% of National Health Service (NHS) gynaecological units in the United Kingdom were already using the techniques and a further 10% were planning to introduce them in the near future. Information obtained at the start of the ‘MISTLETOE’ survey in early 1993 showed a further increase in that 83% of NHS and 68% of independent hospitals were providing them.

A number of randomised controlled trials comparing the outcome of these treatments with hysterectomy have been reported, largely by the innovators of these techniques in the United Kingdom. Dwyer called for longer term studies for full evaluation. Early results were encouraging but involved relatively few women and were unable to link the complication rates to the experience of the operator. Due to variations in data
collection information was lacking about the incidence of complications. It is known that a number of deaths have occurred associated with these operations. Macdonald et al.\textsuperscript{10} reported a learning curve of experience suggesting a higher likelihood of complications developing in the first few cases undertaken. Guidelines for the training necessary for endometrial ablation and the ideal operative equipment were published in 1994 by the Royal College of Obstetricians and Gynaecologists Working Party on Training in Gynaecological Endoscopic Surgery\textsuperscript{11} and by the British Society for Gynaecological Endoscopists\textsuperscript{12}. Both of these reviews were based on a consensus view rather than on scientific evaluation. However it is possible that many surgeons are undertaking the operations without having satisfied these guidelines. The guidelines also recommend that there should be continuing audit of these procedures.

In conjunction with the development of these guidelines a working party involving members of the Royal College of Obstetricians and Gynaecologists and the British Society for Gynaecological Endoscopists was set up to evaluate all current methods of endometrial ablation and resection in order to develop standards for the effectiveness and safety of these techniques. The Department of Health funded a prospective survey of all endometrial destruction operations carried out in England, Wales and Northern Ireland in one year. This paper describes the results of the survey.

**METHODS**

The survey was called the Minimally Invasive Surgical Techniques—Laser, EndoThermal Or Endoresection survey (MISTLETOE). The operations investigated were: combined (diathermy loop and rollerball used together); resection (diathermy loop used alone); rollerball (rollerball diathermy used alone); laser ablation (laser energy used); radiofrequency ablation (radiothermal energy used); and cryoablation (freezing used).

**Pilot study**

Initially a pilot study was set up at four hospitals: Arrowe Park, Upton; Alexandra, Cheadle; Saint Mary’s, Manchester; Countess of Chester, Chester. They were selected because of geographical convenience and because together they performed all these procedures. An independent hospital was included to elucidate any differences that existed between the methods of data collection in the private sector and the NHS. The various forms for data collection which were being developed were modified following information from the pilot sites. The pilot sites were also used to formulate chains of communication which could be replicated nationally in over 400 hospitals.

**Main survey**

All national gynaecological units were contacted by mail or telephone and characterised according to: 1. those providing one or more of the techniques; 2. those where a service was planned before April 1994; and 3. those where there was little chance of a service being instituted before April 1994. A registration form, designed to gain as much information as possible about previous experience and training courses attended, was sent to all consultants and any junior staff who were undertaking endometrial ablation. Almost 300 NHS clinical directors for gynaecology and 300 directors of nursing services were approached to take part in the survey. With their permission, secretarial, ward and theatre staff were contacted and posters and information leaflets distributed. This resulted in over 500 named contacts in the secretarial, ward and theatre areas, thus allowing a specific person to be contacted should problems arise. Subsequently over 1000 consultant gynaecologists were contacted. In the independent sector almost 200 medical directors and matrons were contacted and again posters and information leaflets distributed. Once approved by each hospital board, named contacts were again identified within these hospitals similar to the NHS hospitals. However in independent hospitals there tended to be just one named contact who dealt with theatre and secretarial queries.

Every hospital which reported that any of these techniques were being performed received monthly mailings from the Royal College of Obstetricians and Gynaecologists Audit Unit. Data forms for each woman undergoing endometrial ablation were sent to the secretarial contact. The theatre contact was sent blank theatre forms on which to record the date and hospital number of all women undergoing endometrial ablation. The completed data forms were returned to the Audit Unit by the secretarial contact and the information entered into a computer. Six-week follow up forms were generated for every data form received, and sent back in the routine mailing.

The information on the theatre forms was also entered into a computer and cases were then cross checked against those entered from the data forms. Lists of missing data forms were then produced and sent to the secretarial contact to obtain a higher rate of return.

Validation studies were performed in a random sample of hospitals who had responded well and in a sample who had not responded. The data were collected on a portable computer by C.O. for 349 cases from 12 responding hospitals. This information was compared with that returned on the data forms. Data were also obtained of 281 cases from a sample of 12 nonresponding hospitals.

Ethical permission was not deemed necessary for the study as it was a survey without direct involvement of
the woman. This was in accord with European directives on confidentiality of patient data. All the women were flagged on the NHS central registry in Southport, a division of the Office of Population, Censuses and Surveys (OPCS), allowing notification to the researchers of cancer registrations and deaths.

**Statistical analysis**

For clarity data were analysed on a patient basis ignoring the fact that the patients were operated on by 690 doctors. It is important to state at this point that not all results are based on the total number of cases but on those cases where fields have been satisfactorily completed. The maximum effect of this is seen in the comparisons of experience versus complications where < 10% of the total cases (1066/10,686) had either no operator experience available or an incomplete complications section on the form. Where the loop diathermy alone group has been used in isolation this is because this group alone had sufficiently high numbers of complications to reveal statistically significant associations when compared with the level of prior experience. Statistical tests used were $\chi^2$, Kolmogorov-Smirnov, Kruskall-Wallis, ANOVA, Mann-Whitney $U$ and $t$ tests. The Kolmogorov-Smirnov one-sample test was used to test continuous data for normality. If data was normally distributed then analysis of variance and $t$ tests were used provided that the requirement for equality of variance was met. For non-normal data the Kruskall-Wallis and Mann-Whitney $U$ test were used. The $\chi^2$ test was used for counts in categories. Relative risk and weighted relative risk were calculated (Mantel-Haenzel). Only tests significant at the 1% level have been reported in this paper, and where repeated comparisons have been made following a significant ANOVA or Kruskall-Wallis to locate where differences lay a Bonferroni correction was made to take account of multiple comparisons. For brevity the significance level and degree of freedom have been included but not the value of the test statistic. The appropriate measure of central tendency for nonparametric tests is the median (semi-interquartile range). However, for clarity and ease of comparison with other work, the mean (SD) have been given for all continuous data.

**RESULTS**

**Baseline characteristics**

The survey initially collected 7955 cases from 300 hospitals in the first year (April 1993 to March 1994) which were 80% of all cases according to the OPCS returns for hysteroscopic therapeutic interventions. With the additional recruitment phase up to October 1994 a total of 10,686 cases were analysed. During the whole survey
Table 1. Characteristics of the women. Values are given as percentages or mean [SD]. DUB = dysfunctional uterine bleeding; DS = duration of symptoms.

<table>
<thead>
<tr>
<th></th>
<th>Loop + ball</th>
<th>Loop alone</th>
<th>Laser</th>
<th>Ball alone</th>
<th>Radiofrequency ablation</th>
<th>Cryoablation</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 4291)</td>
<td>(n = 3776)</td>
<td>(n = 1793)</td>
<td>(n = 650)</td>
<td>(n = 140)</td>
<td>(n = 36)</td>
<td>(n = 10,686)</td>
</tr>
<tr>
<td>Married</td>
<td>89.9</td>
<td>89.5</td>
<td>89.5</td>
<td>87.5</td>
<td>85.5</td>
<td>88.9</td>
<td>89.5</td>
</tr>
<tr>
<td>Age (years)</td>
<td>41.4 [61]</td>
<td>41.7 [63]</td>
<td>41.3 [61]</td>
<td>41.2 [60]</td>
<td>41.6 [52]</td>
<td>40.9 [50]</td>
<td>41.5 [61]</td>
</tr>
<tr>
<td>Parity</td>
<td>2.2 [1.2]</td>
<td>2.2 [1.2]</td>
<td>2.2 [1.2]</td>
<td>2.3 [1.2]</td>
<td>2.2 [1.3]</td>
<td>2.1 [1.4]</td>
<td>2.2 [1.2]</td>
</tr>
<tr>
<td>Previous ablation</td>
<td>4.1*</td>
<td>4.8*</td>
<td>10.1*</td>
<td>11.9*</td>
<td>3.5</td>
<td>17.1</td>
<td>5.9</td>
</tr>
<tr>
<td>DUB</td>
<td>94.0</td>
<td>93.6</td>
<td>89.6</td>
<td>92.5</td>
<td>92.4</td>
<td>100.0</td>
<td>93.0</td>
</tr>
<tr>
<td>DS (months)</td>
<td>35.7bc [33.6]</td>
<td>35.9bc [37.1]</td>
<td>38.0bc [38.0]</td>
<td>38.4bc [39.5]</td>
<td>57.5bc [47.6]</td>
<td>35.4bc [34.1]</td>
<td>36.6 [36.2]</td>
</tr>
<tr>
<td>Haemoglobin&lt;11 g/dL</td>
<td>27.5</td>
<td>30.1</td>
<td>29.3</td>
<td>29.0</td>
<td>30.0</td>
<td>20.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Previous illness</td>
<td>12.0</td>
<td>10.9</td>
<td>10.2</td>
<td>12.8</td>
<td>9.3</td>
<td>22.2</td>
<td>11.4</td>
</tr>
<tr>
<td>Current illness</td>
<td>8.2</td>
<td>8.4</td>
<td>7.8</td>
<td>9.5</td>
<td>8.6</td>
<td>25.0</td>
<td>8.3</td>
</tr>
</tbody>
</table>

*Radiofrequency and cryoablation had significantly higher rates of pre-operative ultrasound contrasted to the other groups (χ², P < 0.00001, df 4).  
*Rollerball and loop alone groups had significantly more pre-operative hysteroscopies than all the other groups (χ², P < 0.00001, df 5).  
*Combined group had significantly more pre-operative hysteroscopies than the radiofrequency ablation and cryoablation groups (χ², P < 0.0001, df 2).  
*Rollerball and combined groups had significantly more cases medically prepared than all the other groups (χ², P < 0.00001, df 5).  

Pre-operative investigations and treatment are shown in Table 2. With radiofrequency and cryotherapy diagnostic pelvic ultrasound was performed much more frequently than with the other methods of endometrial ablation (χ², P < 0.00001, df 5). Medical preparation was used more frequently in the laser and radiofrequency ablation groups than all the diathermy groups (χ², P < 0.005, df 1), and in the combined and rollerball groups more than the loop alone group (χ², P < 0.0005, df 1). For laser ablation there was a higher rate of pre-operative hysterectomy (χ², P < 0.00001, df 5) than all the other methods and hence a higher rate of pre-operative endometrial histology (χ², P < 0.00001, df 5) being available.
Operative findings are shown in Table 3. Fibroids were significantly more likely to be present in women treated with the loop diathermy alone ($\chi^2$, $P < 0.002$, df 5). In the three groups treated with diathermy fibroids were associated with a significant increase in operative haemorrhage ($\chi^2$, $P < 0.001$; Mantel-Haenzel overall crude relative risk 2·73, weighted relative risk 2·64 [95%CI 1·97-3·54]). Resection of these fibroids was not however significantly associated with either operative haemorrhage or uterine perforation. There was also an apparent significant increase in operative haemorrhage in the loop alone treatment group with increasing uterine cavity length (Mann-Whitney U test, $P < 0·01$). However cavity length was also significantly greater in the presence of fibroids (mean 8·45 cm [SD 1·41 cm] vs 9·18 cm [SD 1·68]; Mann-Whitney U test, $P < 0·0001$) and when comparing groups of cases with fibroids ($n = 531$) and without fibroids ($n = 1552$) in the loop alone group, within these subgroups there was no significant difference in operative haemorrhage as the cavity size increased (Mann-Whitney U test, $P = 0·21$ and $P = 0·29$, respectively). In addition when standardising the cavity length to include only those cases where it could be regarded as ‘normal’ (8 ± 1 cm) and comparing the fibroid versus the no fibroid group there was a significantly increased haemorrhage rate in the fibroid group ($\chi^2$, $P < 0·001$, df 1). In other words the presence of fibroids and not the cavity length is the important factor which increases the likelihood of operative haemorrhage.

Endometrial thinning (as assessed subjectively by the operator) was apparently significantly better in those women who under went radiofrequency ablation ($\chi^2$, $P < 0·002$, df 5). With regard to the different drugs used the endometrium was felt to be significantly better prepared with gonadotrophin releasing hormone agonists or danazol compared with progesterone ($\chi^2$, $P < 0·00001$, df 1).

Operative treatment is shown in Table 4. Analysis of the unsupervised group showed that operation times for the four major groups were similar although the loop alone was significantly quicker (Kruskall-Wallis, $P < 0·0001$). For radiofrequency and cryotherapy ablation a relatively fixed shorter time is used resulting in shorter operation times than all the other groups (Kruskall-Wallis, $P < 0·0001$). Significantly more of the laser and loop alone cases were supervised when compared with the combined group ($\chi^2$, $P < 0·00005$, df 1). Fluid loss > 2 L was most often seen with the laser group ($\chi^2$, $P < 0·0001$, df 5). The combined and rollerball groups used more prophylactic antibiotics than all the other groups ($\chi^2$, $P < 0·01$, df 4). The laser, loop alone and combined groups all had shorter hospital stays than the other three groups (Kruskall-Wallis, $P < 0·001$).

**Perioperative morbidity**

Women having laser or rollerball ablation had consistently fewer immediate operative complications (Table 5) and there were fewer occasions where additional emergency surgery was needed (Table 6). The combined diathermy group produced significantly fewer total immediate operative complications than the loop alone approach ($\chi^2$, $P < 0·00005$, df 1). This was a combined effect of reduced haemorrhage and uterine perforations but individually they were only statistically significant at the 5% level. Laser ablation was significantly less likely to result in an emergency hysterectomy than the loop alone ($\chi^2$, $P < 0·005$, df 1). Endometrial thinning agents did not significantly decrease the complication rates or emergency surgery rates.

**Post-operative and post-discharge complications**

There were extremely small numbers of post-operative complications with all of the four main techniques. They were defined as those occurring within the first 24 hours after surgery such as: heavy bleeding, abdominal pain, urinary retention, hypotension, nausea, vomiting, bradycardia, chest pain, cervical shock, urinary tract infection, haematuria, hypotension, pyrexia and deep venous thrombosis. Rates ranged between 0·77% and 2·86% (except 3/36 (8·33%) for the cryoablation group) and there were no significant differences at the 1% level.

Data forms relating to complications occurring up to six weeks post-operatively were returned for 95% of
Table 4. Operative management. Values are given as percentages or mean [SD]. Fluid balance = the difference between the fluid infused and the fluid removed; Fluid checks = time interval between checks of fluid balance.

<table>
<thead>
<tr>
<th></th>
<th>Loop + ball (n = 4291)</th>
<th>Loop alone (n = 3776)</th>
<th>Laser (n = 1793)</th>
<th>Ball alone (n = 650)</th>
<th>Radiofrequency ablation (n = 140)</th>
<th>Cryoablation (n = 36)</th>
<th>TOTAL (n = 10,686)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervised (min)</td>
<td>35.5±[17.1]</td>
<td>32.5±[17.1]</td>
<td>34.7±[15.2]</td>
<td>34.2±[15.1]</td>
<td>—</td>
<td>—</td>
<td>33.9±[16.6]</td>
</tr>
<tr>
<td>Supervised</td>
<td>5.6±</td>
<td>7.9±</td>
<td>9.8±</td>
<td>6.3</td>
<td>11.4</td>
<td>2.8</td>
<td>7.7</td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>97.5</td>
<td>99.5</td>
<td>98.9</td>
<td>99.5</td>
<td>98.4</td>
<td>97.1</td>
<td>98.6</td>
</tr>
<tr>
<td>Fluid balance &gt; 2 L</td>
<td>1.0±</td>
<td>1.5±</td>
<td>5.1±</td>
<td>1.2±</td>
<td>—</td>
<td>—</td>
<td>1.9</td>
</tr>
<tr>
<td>Fluid checks (min)</td>
<td>10.3±[6.5]</td>
<td>10.3±[6.4]</td>
<td>8.0±[4.0]</td>
<td>10.4±[5.8]</td>
<td>—</td>
<td>—</td>
<td>9.8±[6.1]</td>
</tr>
<tr>
<td>Prophylactic antibiotics</td>
<td>41.8±</td>
<td>34.9±</td>
<td>33.8±</td>
<td>45.9±</td>
<td>3.7</td>
<td>16.1</td>
<td>38.0</td>
</tr>
<tr>
<td>Mean stay (nights)</td>
<td>1.04±[1.18]</td>
<td>1.10±[1.27]</td>
<td>0.92±[0.99]</td>
<td>1.40±[1.56]</td>
<td>1.49±[1.39]</td>
<td>1.53±[0.90]</td>
<td>1.07±[1.22]</td>
</tr>
</tbody>
</table>

*Loop alone quickest of the hysteroscopic groups (Kruskall-Wallis, χ² = 240.3222, P < 0.0001).
**Combined group quicker than laser group (Mann-Whitney U test, P < 0.0001).
†Loop and loop alone groups more supervised than combined group (χ², P < 0.0005, df 1).
*LASer most fluid loss (Mann-Whitney U test, P < 0.0001).
*Loop alone more fluid loss than combined and rollerball groups (Mann-Whitney U test, P < 0.0001).
*Combined group more fluid loss than rollerball group (Mann-Whitney U test, P < 0.0001).
*Rollerball and combined groups more use of prophylactic antibiotics than all the other groups (χ², P < 0.01, df 4).
*LASer and loop alone groups more use of prophylactic antibiotics than radiofrequency ablation group (χ², P < 0.0005, df 1).
*LASer, loop alone and combined groups shorter stay than rollerball, radiofrequency ablation and cryoablation groups (Mann-Whitney U test, P < 0.001). Overall difference between groups Kruskall-Wallis, χ² = 111.6580, P < 0.0001.

Table 5. Immediate complications. Values are given as n (%).

<table>
<thead>
<tr>
<th>Complication</th>
<th>Loop + ball (n = 4291)</th>
<th>Loop alone (n = 3776)</th>
<th>Laser (n = 1793)</th>
<th>Ball alone (n = 650)</th>
<th>Radiofrequency ablation (n = 140)</th>
<th>Cryoablation (n = 36)</th>
<th>TOTAL (n = 10,686)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemorrhage</td>
<td>99 (2.57)</td>
<td>129 (3.53)</td>
<td>20 (1.17)</td>
<td>6 (0.97)</td>
<td>—</td>
<td>—</td>
<td>254 (2.38)</td>
</tr>
<tr>
<td>Perforation</td>
<td>52 (1.29)</td>
<td>88 (2.47)</td>
<td>11 (0.65)</td>
<td>4 (0.64)</td>
<td>3 (2.14)</td>
<td>—</td>
<td>158 (1.48)</td>
</tr>
<tr>
<td>Cardiovascular/respiratory</td>
<td>22 (0.54)</td>
<td>20 (0.50)</td>
<td>8 (0.47)</td>
<td>3 (0.48)</td>
<td>—</td>
<td>—</td>
<td>53 (0.50)</td>
</tr>
<tr>
<td>Visceral burn</td>
<td>3 (0.07)</td>
<td>3 (0.08)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6 (0.06)</td>
</tr>
<tr>
<td>Fenton’s perineoplasty*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3 (2.14)</td>
<td>—</td>
<td>3 (0.03)</td>
</tr>
<tr>
<td>Total complications†</td>
<td>171.9± (4.20)</td>
<td>229.6± (6.40)</td>
<td>46.2± (2.70)</td>
<td>13.9± (2.10)</td>
<td>6 (4.28)</td>
<td>—</td>
<td>474 (4.44)</td>
</tr>
</tbody>
</table>

*χ², P < 0.00001. Difference between percentages 3.7 (95% CI 2.5–4.9)².
**χ², P < 0.00005. Difference between percentages 4.3 (95% CI 2.9–5.7)².
†Although strictly not a complication of the radiofrequency equipment usage this additional procedure was required to enable the guard to be inserted and has therefore been included in this section.
‡The totals in the table cannot be calculated by simply adding the individual complications. Some cases had more than one complication and some complications were not specified (cf laser total > sum of individuals).

cases in the first 12 months and 80% subsequently. Complications were uncommon and included apart from the above: endometritis, septicaemia, pneumonia, peritonitis, hysterectomy, laparotomy and bowel repair, and pulmonary embolism. Rates ranged from 1.25% to 4.58% (except 3/36 (8.33%) for the cryoablation group) and there were no significant differences at the 1% level.

Deaths

Ten deaths were reported but only two appeared to be directly related to the ablation/resection procedure. One followed brain stem coning in association with a malignant glioma during a combined procedure and the other streptococcal septicaemia three weeks after a loop resection. Examples of non direct deaths were diabetic coma several months post-operatively, carcinomatosis and accidental burning. Direct mortality rates were 2 in 10,000 for the combined procedure and 3 in 10,000 for the loop alone.

Analysis of complications by surgeons’ experience

Six hundred and ninety doctors returned data forms, 96% of whom had previously completed a questionnaire.
Table 6. Intraoperative emergency surgical procedures carried out. Values are given as n (%).

<table>
<thead>
<tr>
<th>Emergency surgery</th>
<th>Loop + ball (n = 4291)</th>
<th>Loop alone (n = 3776)</th>
<th>Laser (n = 1792)</th>
<th>Ball alone (n = 650)</th>
<th>Radiofrequency ablation (n = 140)</th>
<th>Cryo-ablation (n = 36)</th>
<th>TOTAL (n = 10,686)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hysterectomy</td>
<td>25 (0.60)</td>
<td>42* (1:14)</td>
<td>2* (0.11)</td>
<td>1 (0.16)</td>
<td>1 (0.71)</td>
<td>--</td>
<td>71 (0.66)</td>
</tr>
<tr>
<td>Laparoscopy</td>
<td>20 (0.41)</td>
<td>19 (0.51)</td>
<td>3 (0.17)</td>
<td>3 (0.48)</td>
<td>2 (1:42)</td>
<td>--</td>
<td>47 (0.44)</td>
</tr>
<tr>
<td>Laparotomy</td>
<td>3 (0.07)</td>
<td>5 (0.14)</td>
<td>--</td>
<td>--</td>
<td>1 (0.71)</td>
<td>--</td>
<td>9 (0.01)</td>
</tr>
<tr>
<td>Cervical tears</td>
<td>2 (0.05)</td>
<td>3 (0.08)</td>
<td>1 (0.06)</td>
<td>2 (0.32)</td>
<td>--</td>
<td>--</td>
<td>8 (0.01)</td>
</tr>
<tr>
<td>Total emergency surgery*</td>
<td>50* (1:36)</td>
<td>69* (2:39)</td>
<td>6* (0.34)</td>
<td>6* (1:11)</td>
<td>4* (2:86)</td>
<td>--</td>
<td>135 (1:26)</td>
</tr>
</tbody>
</table>

*P < 0.005. Difference between percentages 1.03 (95% CI 0.66-1.40)32.

Table 7. Operator experience subdivided into six groups and contrasted with the presence or absence of any immediate complications, uterine perforations and operative haemorrhage in the loop alone group. Cases relate only to those where complete data on complications and operator experience were available and where cases were not supervised. (The loop alone group has been used because it was the only group which demonstrated this trend. In all other groups there were no significant trends related to operator experience and when all groups were combined this trend was lost. This is almost certainly related to the higher numbers of complications in the loop alone group.)

<table>
<thead>
<tr>
<th>Experience</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤100</td>
</tr>
<tr>
<td>Immediate comp.*</td>
<td>1208 (91.9)</td>
</tr>
<tr>
<td></td>
<td>107 (8.1)</td>
</tr>
<tr>
<td>Uterine perforations†</td>
<td>1262 (96.0)</td>
</tr>
<tr>
<td></td>
<td>53 (4.0)</td>
</tr>
<tr>
<td>Operative haemorrhage‡</td>
<td>1263 (96.0)</td>
</tr>
<tr>
<td></td>
<td>52 (4.0)</td>
</tr>
</tbody>
</table>

χ2 for trend: *P < 0.005; †P < 0.00005; ‡not significant (P > 0.40).

detailing their experience and attendance at training courses. Of the doctors performing diathermy procedures only 69% had attended a previous training course and only 48% reported previous supervised experience. In contrast, of those doctors using laser 99% had attended a previous training course and 93% reported previous supervised experience. The number of cases submitted per doctor ranged between 1 to 222 (Fig. 1). There was no significant difference in complication rates between women operated on by doctors who had attended courses and those who had not. There was no overall level of operator experience above which women were less likely to have complications (Mann-Whitney U test, P = 0.035). However there was a significant trend in the loop alone group suggesting overall that the more experienced the operator the less likely the woman was to have an immediate complication (χ2 test for trend, P < 0.001). Separate analysis of the two most common complications, uterine perforation and operative haemorrhage, showed that the trend was related to the reduction in uterine perforations (χ2 test for trend, P < 0.00001) (Table 7).

DISCUSSION

The number of women with excessive menstruation treated by endometrial ablation has increased from 1988 onwards. This rise has probably slowed down over the last two years due to the introduction of medicated intrauterine devices and laparoscopic hysterectomy performed by some of the enthusiasts of endometrial ablation. The number of operators however is ever increasing as more junior grades learn endometrial ablation. This may be partly due to the apparent economic advantage which these methods have over hysterectomy15.

The objective of obtaining data on the vast majority of cases was achieved. For the first year of the survey the 7955 cases we recorded were about 80% of all the cases done in that year, according to the OPCS returns
for hysteroscopic therapeutic interventions during 1993 to 1994. This will be further checked by retrospective validation studies. With 10,686 cases this is by far the largest study of endometrial ablation and resection.

Our validation study of the data forms showed that there was no systematic difference in the rates of complications between the recorded cases and those that were not recorded. Our validation study of the non responding hospitals showed that the overall complication rates were marginally lower in these hospitals. These two pieces of evidence suggested that the reported cases were representative of overall practice and that there was not under reporting of serious complications.

The size of the survey has allowed detailed comparisons of the complications for each treatment. Laser treatment in particular has been shown to be very safe in this survey. This is supported by the large studies of Erian and Garry. The rollerball was also shown to be very safe when compared with the other diathermy techniques. The studies of Daniell and Fraser suggested that low complication rates are associated with the rollerball technique. The resection loop alone should be abandoned in favour of the combined approach or one of the ablation techniques, as the complication rates for the resection alone group were significantly greater. This cannot be explained by the increased presence of fibroids as fibroids were only associated with increased operative haemorrhage and not perforation. Resection of the fibroids was not associated with either additional increased bleeding or perforation. Holm-Nielsen conducted thermographic assessment of acute tissue effects during loop resection and concluded that great care is needed in the cornual and isthmic regions. Nelson's recent large series favours the combined approach over the loop alone. During the survey at least one consultant changed his practice from loop to combined as a direct result of the preliminary findings being circulated.

Radiofrequency ablation and cryoablation were used in only a few units during the survey and the small number of cases reported made interpretation of the results difficult. Cryoablation has been advocated for more than 25 years in various forms. Both may be appropriate in individual women and certain hospitals. Investigations into alternative nonhysteroscopic ablation techniques such as the "hot water balloon" continue. Whilst having the advantage of being relatively simple they are all performed 'blind' and therefore should be used with caution only and as part of a research protocol.

The use of hormonal endometrial preparations has been recommended and occurred in more than 80% of women in each group. This adds to the cost of the procedure. The perceived improved effect on endometrial thinning was greater with either gonadotrophin releasing hormone agonists or danazol than with progesterone (\(\chi^2, P < 0.00001, df 1\)), but this did not significantly decrease the complication rates or risk of emergency surgery in this survey. This would support Vandamme who has suggested that endometrial preparation is of no benefit overall. Pelvic ultrasound is often available to assess menorrhagia but only a small number of women in this survey had this performed, apart from those in the radiofrequency and cryotherapy ablation groups. However it has been demonstrated that ultrasound can be used effectively in both pre-operative selection and in post-operative follow up to assess the reduction of endometrial thickness and the formation of adhesions.

Relatively small numbers of women in the survey were operated on using local anaesthesia alone. Ferry and Rankin have reported a large series of women undergoing the combined technique under local anaesthesia with good results which compared favourably with women who had general anaesthesia.

A major component of the study was to investigate the relationship between operator experience and complications. It is notable that lack of attendance at a training course did not affect the rate of perioperative complications. It was not possible for us to identify a required level of experience for the performance of these techniques unsupervised, except in the loop alone group where increasing operator experience was associated with decreasing complication rates (Table 7). The survey included the work of 690 doctors many of whom had relatively little experience and it appears that most doctors are careful when they begin to perform endometrial ablation. Whether lack of experience will result in more treatment failures will become apparent with the twelve month follow up information on success and satisfaction on the part of the women.

The correlation between experience and uterine perforation in the loop alone group is interesting and at odds with the findings of the Scottish hysteroscopy audit group which studied predominantly resection cases and which did not demonstrate that previous experience was related to complications or outcome. One drawback with the Scottish audit was that there were only 26 operators studied (average 38 cases) whereas in this study there were 690 with a wide range of number of cases reported (average 15). Large studies such as the current one are needed to analyse the features associated with such rare complications. The complication rates are of a similar order to the Scottish survey. However it is difficult to assess accurately, as a component of the current survey was to compare the complication rates for the various techniques whereas in the Scottish survey they were calculated as a single rate across all the cases.

Some authors have analysed personal series of cases. Holm's findings were similar in his personal series of 600 cases of loop resection (earlier cases) and the combined loop and ball approach (later cases). Rankin
and Steinberg\textsuperscript{7} reported more than 400 cases of loop resection or the combined loop and ball approach and confirmed that even with this amount of experience the complication rate was similar to that in the whole Mistletoe survey where there were many relatively inexperienced operators. Only a small number of cases were supervised during our survey (<8\%) which again confirms that operators with relatively little experience did not have an increased rate of complications.

Guidelines on the training necessary for endometrial ablation and the appropriate equipment and staffing were published in the report of the Royal College of Obstetricians and Gynaecologists Working Party on Training in Gynaecological Endoscopic Surgery\textsuperscript{11} and by the British Society for Gynaecological Endoscopists\textsuperscript{12}. Both of these reports were based on a consensus view rather than scientific evaluation. Following the results of this survey it may be appropriate for these guidelines to be refined.

**CONCLUSION**

This survey shows that techniques of endometrial destruction have a low morbidity and mortality and that they are relatively easily learned in the apprenticeship system. Later we shall report the effectiveness of endometrial destruction.

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