A possible effect of different light sources on pregnancy rates following gamete intra-Fallopian transfer

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A retrospective study of 34 sequential gamete intra-Fallopian transfer (GIFT) procedures suggested a significant effect on pregnancy rates associated with the different laparoscopic light sources, with a pregnancy rate of 50% in 22 cycles using a halogen light source and 9% in 12 cycles using a xenon light source. Other explanatory variables were explored, but none was to have a significant effect on the pregnancy rate. Further investigation revealed that the xenon light source emitted more ultraviolet light than the conventional halogen light source—suggesting a possible detrimental effect of ultraviolet light on the gametes in the GIFT procedure.

Key words: gamete intra-Fallopian transfer/light/oocytes/ultraviolet radiation

Introduction

Gamete intra-Fallopian transfer (GIFT) was introduced in 1984 (Asch et al., 1984), and since then many infertile couples have undergone the technique. Oocyte retrieval in GIFT is performed laparoscopically under general anaesthesia and may now incorporate the use of laparoscopic camera systems with higher intensity light sources which were originally introduced to aid more complex gynaecological surgery. Whilst GIFT procedures are less commonly performed now with the advent of superovulated intrauterine insemination, it is still an accepted treatment for unexplained infertility (Ranieri et al., 1995), and laparoscopic oocyte retrieval may also be necessary for superovulated ovaries in in-vitro fertilization (IVF) cycles inaccessible to a safe transvaginal approach.

The effect of visible light on human oocytes is not clear. In animal models, however, the effects of components of the electromagnetic wave spectrum have been studied, with chromosomal and developmental abnormalities being observed in the oocytes of various species (Smith, 1993; Mise and Wakahara, 1994; Bavister, 1995; Bradshaw et al., 1995; Cohen et al., 1997).

Clinical experience led us to study the effect of different light sources on the pregnancy rates being achieved with GIFT and resulted in a retrospective study of the previous 18 months.

Materials and methods

Over an 18 month period 38 couples with unexplained primary infertility were started on a cycle of ovulation induction and GIFT.

Ovarian stimulation was achieved with an ultrashort course of buserelin 500 µg s.c. on days 2, 3 and 4 of the cycle (Shire Pharmaceuticals, Andover, UK) and human menopausal gonadotrophin (HMG) i.m. injections of 225 IU daily from day 3 (Serono Laboratories Ltd, Welwyn Garden City, UK). Ovarian monitoring was carried out with transvaginal ultrasound and oestradiol studies. Human chorionic gonadotrophin (HCG)10 000 IU (Serono) was given when the mean follicular diameter of the leading follicle reached 16–18 mm. Laparoscopy was performed 36 h later under general anaesthetic with the same anaesthetic technique throughout.

Of the 20 couples started on a cycle of GIFT in the first 6 months of the study, two were cancelled because of poor ovarian response. Eighteen GIFT procedures were performed laparoscopically using a halogen 150 W light source (source 150; Down’s Surgical Ltd, Mitcham, Surrey, UK) and no camera.

A possible effect of different light sources on pregnancy rates associated with the different laparoscopic light sources, with a pregnancy rate of 50% in 22 cycles using a halogen light source and 9% in 12 cycles using a xenon light source. Other explanatory variables were explored, but none was to have a significant effect on the pregnancy rate. Further investigation revealed that the xenon light source emitted more ultraviolet light than the conventional halogen light source—suggesting a possible detrimental effect of ultraviolet light on the gametes in the GIFT procedure.

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An endoscopic camera system was then installed (Richard Wolfe 5370CCD®, Endocam, Knittlingen, Germany), together with a xenon 300 W light source (Luxtech Fibre-optics 1900®, Luxtech Corporation, Stourbridge, MA, USA). This system was used for the subsequent 13 GIFT cycles apart from one GIFT which was cancelled during this time because of poor ovarian response.

Eight months later the camera system was sent for repair and following that five GIFT cycles were commenced; one was cancelled and four were performed returning to the old technique using the halogen light source and no camera. Following the last procedure embryological support was withdrawn and GIFT could no longer be performed.

High sensitivity HCG estimation was performed on day 28 and a scan was performed 4 weeks following GIFT procedure. Pregnancies were defined as biochemical, ongoing, ectopic or miscarriage.

The same consultant anaesthetist and gynaecologist performed all procedures and the same embryologist was present for all procedures using similar techniques and culture media.

Results

During the first period using a halogen light source, of 18 GIFT procedures there were eight pregnancies, of which two miscarried and six were ongoing. During the second time period when the xenon light source was used 12 GIFT operations were performed and there was one miscarriage. During the third time period using the halogen light source again, four GIFT operations were performed and there were three pregnancies, of which two were ongoing and one was ectopic.

Using a halogen light source the pregnancy rate was therefore 50% and using a xenon light source the pregnancy rate was 8.3%.

A logistic regression was performed to assess the relationship between the different factors measured and the outcome of pregnant/not pregnant. The factors included in the model were age of the woman, years of infertility, number of oocytes
Table I. Descriptive statistics of gamete intra-Fallopian transfer (GIFT) cycles treated with xenon and halogen light source

<table>
<thead>
<tr>
<th></th>
<th>Halogen</th>
<th>Xenon</th>
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</thead>
<tbody>
<tr>
<td>Number of cycles</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Mean age of female partner (years)</td>
<td>32.9 (3.7)</td>
<td>31.6 (3.8)</td>
</tr>
<tr>
<td>Mean years infertility</td>
<td>7.0 (3.0)</td>
<td>5.1 (1.7)</td>
</tr>
<tr>
<td>Mean number of oocytes recovered</td>
<td>6.2 (3.9)</td>
<td>8.1 (4.7)</td>
</tr>
<tr>
<td>Mean number of oocytes replaced</td>
<td>2.4 (0.5)</td>
<td>2.5 (0.4)</td>
</tr>
<tr>
<td>Mean washed sperm concentration ($10^6$/ml)</td>
<td>13.2 (8.1)</td>
<td>14.1 (8.0)</td>
</tr>
<tr>
<td>Mean washed sperm motility (%)</td>
<td>78 (11.0)</td>
<td>80 (6.8)</td>
</tr>
<tr>
<td>Percentage positive pregnancy test (HCG &gt; 25 IU day 28)</td>
<td>50</td>
<td>9</td>
</tr>
<tr>
<td>Percentage live birth rate</td>
<td>36</td>
<td>0</td>
</tr>
</tbody>
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SD shown in parentheses.

recovered, number of oocytes replaced, washed sperm count, washed sperm motility and the light source (Table I). The only significant predictor in the model was the light source, which had an odds ratio of pregnancy on xenon to halogen of 0.03, controlling for other variables in the model (the 95% confidence intervals for this were 0.0016 and 0.62). All other variables mentioned were not significant. This indicates that there was a significant difference in the odds of pregnancy with the two light sources, with the odds for the xenon source being significantly lower than those for the halogen.

Discussion

GIFT performed on couples with unexplained infertility can be expected to give a pregnancy rate of about 30–40% (Ranieri et al., 1995). During the second period of the experience described, we encountered a very low pregnancy rate, and were keen to look for any reason why this should be. There were no differences in the age of the female partner, years of infertility, washed sperm numbers or motility, or number of oocytes collected or replaced. When the light sources were then changed again and the pregnancy rate improved, it became likely that this was the cause of the phenomenon. Alternative explanations include variations in gonadotrophin batches and culture medium. However, these should have affected follicular response (but no difference was seen in oocytes numbers) or should have been reflected in results from other infertility treatments, e.g. IVF; however none was observed. The two light sources were then investigated further using spectral irradiance (Bentham Instruments Ltd, Reading, UK) and it was noted that the spectral irradiance for the xenon light source included more radiation in the ultraviolet (UV) and infrared areas than the halogen light source (Figure 1).

The laboratory requirements for successful culture of gametes and embryos are well known and many factors responsible for damage, including temperature variations, pH variations, toxic substances, culture media constituents and contaminated air have been identified and reviewed (Bavister, 1995; Cohen et al., 1997).

The effect of ultraviolet light UVC (254 nm) and UVA (>330 nm) has been studied on bovine oocytes at the germinal vesicle and metaphase II stage. Both UVA and UVC irradiation caused abnormalities of meiosis and production of maturation promoting factor (MPF) at both germinal vesicle and metaphase II stages. This resulted in abnormal parthenogenetic activity, with loss of the female pronucleus being seen after UVC irradiation and an abnormal female pronucleus after UVA irradiation in metaphase II oocytes. Meiotic arrest and abolition of the spindle occurred in germinal vesicle stage oocytes (Bradshaw et al., 1995). Other studies of brief exposure to UV light of bovine secondary oocytes revealed increased membrane lysis and increased methionine uptake, but reduced methionine incorporation into protein and a marked difference in the patterns of protein synthesis (Smith, 1993). Abnormalities in the development of dorsal axis structures have been reported after UV irradiation of the mature oocytes of Xenopus laevis (Mise and Wakahara, 1994), and DNA damage in the egg nucleus leading to a failed activation of MPF and prolongation of prophase and metaphase was noted in newt oocytes following UV irradiation (Iwao et al., 1993).

Figure 1. Spectrum of wavelength intensities.
the microtubular structure and hence result in chromosomal and DNA damage (Ashwood-Smith and Edwards, 1996).

Visible light appears to inflict far less damage on oocytes with mouse oocytes exposed to light at 4000 lux for 1, 2, or 4 h showing no differences after IVF in rates of cleavage, implantation and normal offspring compared to controls (Barlow et al., 1992). This finding was supported by work on rabbit unfertilized and pronuclear oocytes exposed to fluorescent light where again no effect was seen on subsequent implantation and development (Bedford and Dobrenis, 1989).

It would appear therefore that there may be evidence to support the hypothesis that the increased UV light from the xenon light source could have affected the pregnancy rates. Further studies may be indicated on both the effect of UV and infrared emissions, but in the meantime it is suggested that ultraviolet filters could be considered or camera systems incorporating high intensity light sources be avoided when performing GIFT.

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References

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