Monozygotic twinning and IVF/ICSI treatment: a report of 11 cases and review of literature

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Monozygotic twinning is a relatively rare event in in-vivo conception, being estimated to occur in 0.42% of all births. The underlying mechanism for monozygotic twin formation is the division of the embryo early in its development. Separation of cells may theoretically occur before or after inner cell mass formation. In this analysis we report 11 cases of monozygotic twins resulting from IVF or intracytoplasmic sperm injection (ICSI) treatment cycles performed between 1991 and 1998 at St James’s University Hospital, Leeds, and Bourn Hall Clinic, Cambridge, UK. Six cases (55%) followed treatment with ICSI and seven cases (64%) were in women aged ≥35 years. This article also reviews the scientific literature discussing information pertaining to frequency, aetiology and potential complications of the monozygotic twinning phenomenon. We conclude that patients at risk of monozygotic twinning are those aged >35 years of age and those who had artificial opening in the zona pellucida by application of micromanipulation techniques. Women undergoing assisted conception treatment, particularly those with these two risk factors, must be informed of the low but definite risk of monozygotic twinning when counselled regarding the number of embryos to be transferred and chances of multiple births.

Key words: complications/ICSI/IVF/monozygotic twinning/prenatal diagnosis

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Introduction

Monozygotic twinning is a relatively rare event in in-vivo conception and is estimated to occur in 0.42% of all births (Bulmer, 1970). It has been suggested that identical twinning occurs more frequently after human IVF (Edwards et al., 1986), although the true incidence is obscured by multiple embryo transfer and early embryonic demise. This phenomenon has been attributed to a number of factors, including ovulation induction (Derom et al., 1987; Wenström et al., 1993), in-vitro culture conditions, malformation or hardening of the zona pellucida, multiple cavity formation in the blastocyst, in-vitro manipulation of the oocyte, and artificial opening of the zona pellucida (Yovich et al., 1984; Edwards et al., 1986; Cohen et al., 1990).

The underlying mechanism for monozygous twin formation is the division of the embryo early in its development. Separation of cells may theoretically occur before or after inner cell mass formation. Although totipotency of early blastomeres in many species has been established (Tarkowski, 1959; Moore et al., 1968; Rossant, 1976; Willadsen, 1979; Nicholas and Hall, 1992), spontaneous separation and independent growth of these early cells before inner cell mass formation has never been observed. However, if such an event occurs in the human, the formation of separate amnions and chorions make this indistinguishable from dizygotic twinning (Bulmer, 1970). Experimental evidence suggests three time-points at which the inner cell mass may split. In the mouse, Hsu and Gonda (1980) have reported inner cell mass subdivision during attachment of hatched blastocysts to the surface of the culture vessel. The subdivision resulted in the formation of two independent egg cylinders and their bilateral outgrowth, which was interpreted as artificial monozygotic twinning. The spontaneous development of a double inner cell mass before hatching has also been seen in the mouse (Chida, 1990), and is reported to occur at rates of 3.1 and 0.6% after in-vitro or in-vivo fertilization respectively.

The membrane pattern in monozygous twins depends on the time when splitting of the zygote takes place. If splitting occurs within the first 4 days after fertilization, that is, before the chorion has differentiated (Figure 1), separate chorions will develop for each twin as in dizygotic twin pairs. Such dichorial monozygotic twins may have either fused or separate placentae. If the pre-implantation blastocyst splits during the latter part of the first week of gestation (Figure 2), there will be a single placental disc comprising a single chorion, but each twin will have an individual

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amniotic sac (monochorionic, diamniotic). Rarely, there may be splitting during the second week, with the two twins sharing the resultant single amniotic sac as well as a single chorion (monochorionic, monoamniotic).

The most pertinent hypothesis of monozygotic twinning in human embryos generated in vitro is the division of the inner cell mass during hatching. This has been recorded in cattle (Ozil et al., 1982; Massip and Vanderzwalmen, 1983), where a blastocyst under cinematographic observation was seen to divide into two ‘complete’ halves. The process began with the production of a few trophoderm cells through a small hole in the zona pellucida. This herniation continued expanding, eventually incorporating part of the inner cell mass which had moved towards the zona opening. The two ‘half inner cell mass’ complexes remained connected by a narrow cellular bridge, which the authors proposed could break in utero, giving rise to identical twins. Human embryos may behave in a similar fashion as they start hatching through narrow artificial gaps. Blastocysts with a partially dissected zona pellucida may lose trophoblastic vesicles as they expand and attempt to hatch through the narrow gap (Malter and Cohen, 1989). Further implications of the size of zona pellucida openings have clearly been demonstrated in the rodent model (Cohen and Feldberg, 1991). Most importantly, a single small hole may lead to a figure-of-eight configuration at the time of hatching, while multiple gaps of the same dimension promote multiple herniation. Any of these situations in the human may result in unexpected splitting of the inner cell mass. If this occurs after the differentiation of the trophoblast (which forms the chorion), a monochorionic/diamniotic twin pregnancy follows. It is thought that monochorionic/monoamniotic twins are produced as a result of division at a later stage (Bulmer, 1970).

With its constant population frequency, monozygous twinning was for many years felt to be independent of genetic influence. Harvey et al. (1977) and Shapiro et al. (1978), however, reported 10 families with multiple pairs of monozygous twins, a frequency far exceeding the general population incidence. In those studies, monozygotic twin parents (both male and female) of monozygotic twins were reported. Pedigree analysis of monozygous twin families has suggested a monoendic mode of inheritance transmitted by both parents, but with low penetrance (Olson-Segreti et al., 1978; Parisi et al., 1983). The dizygotic twinning rate, on the other hand, varies largely by race, from 1.3/1000 in Japan to 7–9/1000 in the USA and Europe and 50/1000 in Nigeria (MacGillivray, 1986).

Case studies

We report 11 cases of monozygotic pregnancies resulting from IVF or intracytoplasmic sperm injection (ICSI) treatment cycles performed either at St James’s University Hospital, Leeds or at Bourn Hall Clinic, Cambridge, between 1991 and 1998. In all cases, monozygosity was detected during the routine 7–10 weeks gestation transvaginal ultrasound scan and subsequently confirmed by histological examination of the dividing membranes after delivery.

All patients underwent a long down-regulation protocol (Macnamee and Brinsden, 1999) followed by ovarian stimulation with gonadotrophins and ultrasound-guided transvaginal egg recovery (Brinsden, 1999). Embryo transfer was performed 48–52h post-egg collection.

Figure 1. Monozygotic twinning arising from division in the first 4 days of embryo development (adapted from Fox, 1978).

Figure 2. Embryo division after the first week of development demonstrates greater sharing of trophoblastic-derived tissue and amniotic sacs (adapted from Fox, 1978).
Between 1991 and 1998 there were 662 multiple births following IVF treatment in the two centres, six of which were monozygotic twins (IVF monozygotic twinning rate 0.9%). During the same period, there were another 56 multiple births following ICSI treatment, 5 of which were monozygotic twins (ICSI monozygotic twinning rate 8.9%). The mean age of patients was 35.2 years (range 28–38 years) and the mean duration of infertility was 3.8 years (range 2–15 years). As illustrated in Table I, eight patients had primary subfertility while the other three had secondary subfertility.

Seven cases of monozygotic twining occurred in women aged ≥35 years (64%), four of whom had ICSI treatment. In one case (number 7), although two embryos were replaced, a quadruplet pregnancy was achieved, resulting in the delivery of non-identical males and female monozygotic twins. In two other cases (number 5 and 10), a triplet pregnancy occurred with monozygotic twins co-existing with a singleton pregnancy.

The overall Caesarean section rate was 54.5% (6/11), which is considerably higher than the quoted rate for IVF/ICSI twins (Seoul et al., 1992; Tan et al., 1992). Two Caesarean sections were performed at term (37 weeks), while the other four were performed at 34–36 weeks gestation.

There were four neonatal deaths complicating two pregnancies (neonatal mortality rate 18.2%). The first was a monochorionic, monoamniotic pregnancy in a 34 year old woman who had IVF treatment due to tubal disease (number 2). Having previously had a cone biopsy, as well as a second trimester miscarriage at 20 weeks gestation, cervical incompetence was suspected. Despite cervical cerclage in this pregnancy she went into premature labour at 25 weeks gestation and delivered twin boys, who died shortly after delivery due to extreme pre-maturity. The other case was a woman aged 35 years who had conceived a diamniotic, monochorionic twin pregnancy following her first ICSI treatment. Intrauterine fetal death of both twins was diagnosed at 26 weeks due to twin-to-twin transfusion syndrome (TTTS), which was subsequently confirmed on histology. The birth weight of the recipient fetus was 925 g compared with 590 g of its donor twin.

There were three cases of monoamniotic, monochorionic twins (27.3%), all of which were conceived subsequent to IVF treatment. As discussed above, one of these cases ended in premature birth at 25 weeks gestation. The other two pregnancies however progressed normally resulting in the delivery of healthy babies at 35 and 37 weeks gestation. The diagnosis of monochorionic, monozygotic twinning was made at the viability scan between 7–10 weeks gestation (Figures 3 and 4). The birth weights, gestation and mode of delivery for the eleven cases are shown in Table II.

**Background**

The first monozygotic twin pregnancy resulting from IVF treatment was reported by Yovich et al. and was a delivery of identical male twins within a monochorionic, diamniotic placental

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**Table I. Patient characteristics (in no case did treatment involve assisted hatching)**

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age</th>
<th>Aetiology</th>
<th>Duration of infertility (years)</th>
<th>Parity</th>
<th>Attempt no.</th>
<th>Treatment</th>
<th>No. of embryos transferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>MFI</td>
<td>2</td>
<td>P0+0</td>
<td>1</td>
<td>ICSI</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>TD</td>
<td>4</td>
<td>P0+1</td>
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<td>3</td>
<td>35</td>
<td>MFI</td>
<td>4</td>
<td>P0+0</td>
<td>3</td>
<td>ICSI</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>MFI</td>
<td>2</td>
<td>P0+0</td>
<td>1</td>
<td>ICSI</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>37</td>
<td>Endometriosis</td>
<td>2</td>
<td>P1+0</td>
<td>2</td>
<td>IVF</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
<td>TD</td>
<td>15</td>
<td>P0+0</td>
<td>6</td>
<td>IVF</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>38</td>
<td>MFI</td>
<td>2</td>
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<td>ICSI</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>38</td>
<td>Endometriosis</td>
<td>2</td>
<td>P0+0</td>
<td>2</td>
<td>IVF</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>31</td>
<td>TD</td>
<td>2</td>
<td>P0+0</td>
<td>3</td>
<td>IVF</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>37</td>
<td>MFI</td>
<td>3</td>
<td>P0+0</td>
<td>1</td>
<td>ICSI</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>34</td>
<td>MFI</td>
<td>4</td>
<td>P1+0</td>
<td>1</td>
<td>IVF</td>
<td>3</td>
</tr>
</tbody>
</table>

MFI = male factor infertility; TD = tubal disease; ICSI = intracytoplasmic sperm injection.

**Figure 3.** Ultrasonic image of a diamniotic, dichorionic pregnancy at 8 weeks gestation.
Table II. Summary of the type of delivery, birth weights and outcomes

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Type of delivery</th>
<th>Gestation (weeks)</th>
<th>Birth weight (g)</th>
<th>Sex</th>
<th>Type</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LSACS</td>
<td>34</td>
<td>1642 &amp; 1955</td>
<td>F &amp; F</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
<td>2</td>
<td>SVD</td>
<td>25</td>
<td>488 &amp; 462</td>
<td>M &amp; M</td>
<td>Monoamniotic, Monochorionic</td>
<td>NND</td>
</tr>
<tr>
<td>3</td>
<td>SVD</td>
<td>26</td>
<td>590 &amp; 925</td>
<td>M &amp; M</td>
<td>Diamniotic, Monochorionic</td>
<td>NND</td>
</tr>
<tr>
<td>4</td>
<td>SVD</td>
<td>36</td>
<td>1583 &amp; 1406</td>
<td>M &amp; M</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
<td>5</td>
<td>LSACS</td>
<td>35</td>
<td>2000, 1720, 2025</td>
<td>M, M &amp; F</td>
<td>Monoamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
<td>6</td>
<td>SVD</td>
<td>36</td>
<td>1850, 1720</td>
<td>F, F</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
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<td>LSACS</td>
<td>36</td>
<td>1204, 1190, 1134, 800</td>
<td>M, M &amp; F,F</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
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<tr>
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<td>37</td>
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<tr>
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<td>SVD</td>
<td>36</td>
<td>1692, 1754</td>
<td>F, F</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
<td>10</td>
<td>LSACS</td>
<td>35</td>
<td>2000, 1720, 2025</td>
<td>M, F &amp; F</td>
<td>Diamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
<tr>
<td>11</td>
<td>LSACS</td>
<td>37</td>
<td>2010, 1970</td>
<td>F, F</td>
<td>Monoamniotic, Monochorionic</td>
<td>A&amp;W</td>
</tr>
</tbody>
</table>

LSACS = lower segment Caesarean section; SVD = spontaneous vaginal delivery; F = female; M = male; A&W = alive and well; NND = Neonatal death.

Figure 4. Ultrasonic image of a monoamniotic, monochorionic pregnancy at 10 weeks gestation.

and membrane configuration (Yovich et al., 1984). The natural incidence of twins occurring spontaneously is 1 in 89 deliveries (Edwards et al., 1986). Approximately 20% of these twin gestations are monozygotic. Early separation of the embryo before day 4 is likely to lead to the complete reduplication of separate amniotic and chorionic membranes, as the amnionblasts are still closely approximated to the cytotrophoblast. However, over the ensuing days, the extra-embryonic coelom separates the two structures and any splitting in the second week will lead to reduplication of the amniotic membranes within the single chorionic enclosure. By the end of the second week, the amniotic cavity almost completely envelops the developing embryo, and any division after this stage tends to be monoamniotic as well as monochorionic. The natural incidence of the latter phenomenon is around 1 in 8000 (Edwards et al., 1986). Incomplete separation at this stage can lead to the very rare event of conjoined twins. The zona pellucida consists of an acellular sheath of mucopolysaccharide and protein surrounding the ovum. It has been argued that the zona pellucida serves functionally to limit sperm penetration to species able to recognize its specific mucopolysaccharide. The zona might also provide a mechanical barrier, limiting the extension or fusion of the dividing inner cell mass. Mechanical or chemical disruption of the mucopolysaccharide architecture or abnormal mucopolysaccharide synthesis could lead to monozygous or monoamniotic twinning (Alikani et al., 1994).

The importance of the zona pellucida in hatching has become particularly clear following the routine application of micro-manipulation techniques for assisted fertilization and assisted hatching. Artificial openings introduced in the zona pellucida may complicate the natural process of hatching, in that the embryo may bypass its own mechanism of local zona pellucida lysis and choose to escape through the already established opening (Cohen and Feldberg, 1991; Alikani and Cohen, 1992). The dimensions of this gap can impose a physical restriction on the emerging embryo, causing it to split (Cohen et al., 1990). The effectiveness of zona manipulation in increasing pregnancy rates has been widely discussed. The data of Slotnick and Ortega (1996) suggest that a 40-70% increase in pregnancy rates can be achieved through zona manipulation procedures. In this report the incidence of monozygotic twinning subsequent to ICSI treatment was 8.9% (5/56) compared with 0.9% (6/662) following conventional IVF treatment. These figures add further support to the notion that mechanical or chemical disruption of the mucopolysaccharide architecture of the zona pellucida could lead to monozygous or monoamniotic twinning (Alikani et al., 1994).

A naturally thin zona pellucida may affect the hatching process in the same way if, for instance, the blastocyst protrudes at more than one site due to multiple sites of zona lysis. The subtle and
gradual decrease in the average thickness of the zona pellucida with increasing age (Cohen et al., 1992) may be an important observation in view of the epidemiological data on the frequency of monzygotic twinning in nature. Interestingly, following natural conception, the only factor found to affect an otherwise constant frequency of monzygotic twinning is maternal age (Bulmer, 1970). The two phenomena may therefore be related. In this study seven out of the eleven cases of monzygotic twinning (64%) occurred in women aged \( \geq 35 \) years.

**Prenatal determination of chorionicity and zygosity**

It has been possible for a number of years to determine chorionicity *in utero* by ultrasound (Barss et al., 1985; Mahony et al., 1985), and routine prenatal determination of chorionicity has been widely recommended (Barss et al., 1985; Hertzberg et al., 1987; Filly et al., 1990; Fisk and Bryan 1993; Monteagudo et al., 1994). This is because perinatal morbidity and mortality is three to fivefold higher in monochorionic compared with dichorionic pregnancies (Benirschke and Kim, 1973; Neilson et al. 1989; Bejar et al., 1990), and knowledge of chorionicity may alter antenatal management. The increase is largely attributed to the presence of placental vascular anastomoses. In our series, one out of the three monoamniotic monochorionic pregnancies ended in pre-mature labour at 25 weeks gestation.

The determination of chorionicity prenatally is based on the use of ultrasound to identify fetal gender, the number of placental masses, and inter-twin membrane thickness (Barss et al., 1985; Mahony et al., 1985; Hertzberg et al., 1987; Townsend et al., 1988; Winn et al., 1989).

Histologically, the dividing membrane in monochorionic twins is formed by two layers of amnion, and in dichorionic twins, by two layers of chorion and two layers of amnion. Therefore, dichorionic twins have thicker membranes than monochorionic twins, and this difference can be perceived quantitatively on ultrasound (Mahony et al., 1985; Barss et al., 1985). The dichorionic septum has a mean thickness of 2.4 mm compared to 1.4 mm in septa from monochorionic placentae (Winn et al., 1989). Several studies report accuracies in the region of 80% for the prediction of chorionicity using septal thickness (Hertzberg et al., 1987; Townsend et al., 1988).

The difference between the two types of membranes is more pronounced in the first trimester. There are two embryological reasons for this. First, the chorion in the intervening septum is much thicker than in later pregnancy (Warren et al., 1989). A thick septum was found in 92% of 85 dichorionic twin pregnancies, and thin septum in 88% of 16 monochorionic pregnancies in one transabdominal ultrasound study (Kurtz et al., 1992). Secondly, the amnion can normally be distinguished separately from the chorion in singleton pregnancies, the intervening cavity being the extra-embryonic coelom. This situation persists until the amnion moves to fuse with the chorion at 10–14 weeks (Warren et al., 1989). Therefore, the constituent layers of intervening septum can be observed ultrasonically. Monteagudo et al. (1994) reported 100% accuracy in 43 twin and high order multiple pregnancies using transvaginal ultrasound to look for the above features. Thus, it appears that chorionicity determination is most accurate in the first trimester, both on theoretical grounds and on the basis of the limited literature. The optimal gestation at which to perform ultrasonic chorionicity determination is 9–10 weeks (Monteagudo et al., 1994). In this analysis the diagnosis of zygosity was made accurately using transvaginal ultrasonography at 7–10 weeks gestation in all the reported cases.

**Complications of monzygotic twinning**

The various theories of monzygotic twinning suggest that single-zygote twinning is an anomalous embryonic process and thus itself a malformation (Cameron et al., 1983; Baldwin, 1994). Monzygotic twins are more likely to be delivered prematurely (Sebire et al., 1997), be significantly growth discordant (Maier et al., 1995), or have developmental anomalies (Honma et al., 1999). They are also over-represented in all patterns of twin mortality throughout pregnancy. A higher perinatal mortality rate (PMR) among monzygotic twins relative to singletons is widely recognized (Fowler et al., 1991). Population studies from many countries indicate that perinatal mortality rates for twins are between four and seven times the rate for singletons (Golding, 1991; Gaucherand et al., 1994; Minakami et al., 1999). Mortality rates are higher for monochorionic compared to dichorionic twins, 190 versus 75 per 1000 deliveries respectively (Naeve et al., 1978; Bleker et al., 1979; Sebire et al., 1997).

Monoamniotic twins are at risk of complications that are unique to the presence of the two fetuses within the same sac (Pauls, 1969; Lumme and Saarikoski, 1986). Umbilical cord entanglement is a common problem and is the likely cause of severe episodes of hypotension and hypoxic/ischaemic lesions and the very high fetal loss rates observed in these pregnancies (30–50%) (Benirschke, 1961; Bulla et al., 1987). Interestingly, rupture of the thin dividing diaphragmatic membrane can lead to the same complication (D’Alton et al., 1984). Fetal entanglement would seem to be a risk, but this complication does not seem to have been reported.

**Twin-to-twin transfusion syndrome**

TTTS complicates 15–30% of diamniotic monochorionic twin pregnancies (Robertson and Neer, 1983; Patten et al., 1989), and accounts for 15–17% of the perinatal mortality (Weir et al., 1979; Steinberg et al., 1990). TTTS is attributed to transfusion of blood via placental vascular anastomoses between the two fetuses’ circulation, causing anaemia and growth retardation in the ‘donor’, and polycythaemia with circulatory overload in the ‘recipient’ (Rausen et al., 1965; Tan et al., 1979; Blickstein, 1990; Minakami et al., 1999). It is postulated that the placenta of the donor twin causes increased peripheral resistance in the placental circulation that promotes shunting of blood to the recipient; the donor suffers from both hypovolaemia due to blood loss and hypoxia due to placental insufficiency (Saunders et al., 1991, 1992). The recipient fetus compensates for its expanded blood volume with polyuria (Rosen et al., 1990) but since protein and cellular components remain in its circulation, the consequent increase in colloid oncotic pressure draws water from the maternal compartment across the placenta. A vicious cycle of hypervolaemia, polyuria, hyperosmolality is established leading to heart failure and polyhydramnios (Weir et al., 1979).
In severe TTTS with polyhydramnios presenting in the second trimester, there is a high risk of perinatal death and brain damage due to a combination of factors, including intrauterine hypoxia and preterm delivery (Fusi and Gordon, 1990; Larroche et al., 1990; Saunders et al., 1992; Maier et al., 1995). In addition, death of one fetus, usually the donor, is associated with subsequent death or hypoxic/ischaemic sequelae in the co-twin (Bendon and Siddiqi, 1989; Sherer et al., 1993; Kilby et al., 1994). The suggested mechanism is disseminated intravascular coagulation after the release of thromboplastin from the dead twin (Thilaganathan et al., 1992; Snijders et al., 1993). However, ventriculomegaly or peripheral gangrene in one of the fetuses has been observed, even when the co-twin is alive (Saunders et al., 1992; Hecher et al., 1994; Okamura et al. 1994). It is curious to note that, although inter-twin vascular anastomoses are universal, chronic TTTS syndrome is almost unknown in monoamniotic twins; acute transfusion is more likely. This may be because the presence of very large anastomoses between the cord insertion on the placenta in the majority of cases (Bajoria et al., 1995). In this series, one out of the eight reported cases of monochorionic diamniotic pregnancies (12.5%) developed severe TTTS resulting in intrauterine fetal death at 26 weeks gestation.

The diagnosis of severe TTTS is based on the ultrasound findings of a monochorionic diamniotic twin pregnancy, with fetuses that are discordant in size (Danskine and Neilson, 1989). The larger twin (presumed recipient) has a distended bladder and is surrounded by polyhydramnios, whereas the smaller twin (presumed donor) always has an empty bladder and the fetus appears to be fixed to the placenta or the uterine wall because of oligohydramnios (Brown et al., 1989; Patten et al., 1989).

Colour Doppler studies in severe TTTS presenting with acute polyhydramnios during the second trimester of pregnancy have demonstrated the presence of several superficial vessels connecting the two circulations (Hecher et al., 1995a). Additionally, umbilical artery pulsatility index (PI) is increased in some donor and recipient fetuses; the former may be the consequence of abnormal placental development and the latter may be the result of polyhydramnios-related compression (Hecher et al., 1995b). Doppler findings in the circulation of the donor fetus (decreased blood flow velocity in both the thoracic aorta and middle cerebral artery) suggest that this fetus is compromised by severe uteroplacental insufficiency, but with the additional disadvantage imposed by chronic haemorrhage and hypovolaemia (Hecher et al., 1995b). In the recipient fetus, there is a decreased PI in the middle cerebral artery and decreased velocity in the aorta, which may be the consequence of hypovolaemia-related congestive heart failure (Zosmer et al., 1994).

If the initial episode of TTTS is not severe, both twins may survive although neurological injury due to congestive cardiac failure caused by circulatory overload in the recipient twin, or hypoxia in the donor twin, could occur (Fisk et al., 1990; Saunders et al., 1991). Furthermore, an adverse outcome of monochorionic twins at 1 year of age was associated with greater birth weight and haemoglobin discordance due to polycythaemia or anaemia in the smaller twin (Wenstrom et al., 1992; Honma et al., 1999). Twins conceived after ovulation induction with or without IVF did not have an increased risk of an adverse outcome compared with naturally occurring twins (Bernasko et al., 1997; Minakami et al., 1998).

Conclusions

The incidence of monochorionic twinning following assisted reproduction techniques is higher than the commonly accepted incidence after in-vivo conceptions. Patients at particular risk of monochorionic twins are those aged ≥35 years and those who had an artificial opening created in the zona pellucida by micromanipulation techniques for assisted fertilization. Hence, it seems prudent to counsel these patients about the potential obstetric complications of monochorionic multiple gestations prior to the initiation of their treatment.

In view of the potentially dangerous complications of monoamniotic, monochorionic twin pregnancies, determination of chorionicity in early pregnancy should be introduced as part of routine practice. This is important, not only because it allows identification of a particularly high-risk group for close monitoring, but also because the management of certain pregnancy complications, such as co-twin demise, differs markedly depending on twin chorionicity.

References


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