Introduction

With an incidence of 3%, adnexal torsion is a common cause of emergency gynaecological procedures [1]. The symptoms are mostly unspecific and diagnosis is therefore not simple. Early diagnosis is essential to preserve organ function and fertility. The increased use of assisted reproductive technologies such as controlled ovarian hyperstimulation (COH), in vitro fertilisation (IVF) and intracytoplasmic sperm injection (ICSI) has led to an increase in the risk of adnexal torsion, particularly in pregnant women or women with ovarian hyperstimulation syndrome (OHSS). Mashiach et al. studied adnexal torsion in 201 women with OHSS over a period of 10 years and reported an incidence of 2.3% in nonpregnant women and an incidence of 16% in pregnant women.
women [2]. The differential diagnosis of adnexal torsion is particularly difficult in combination with OHSS or pregnancy, as abdominal pain, nausea and vomiting can be presenting symptoms of hyperstimulation or pregnancy but also of adnexal torsion. The aim of our review article is to draw attention to this complication of assisted reproductive technology (ART) using case studies from our retrospective analysis of 1411 cases. Together with a review of the literature, we wish to emphasise the importance of early diagnosis for decision-making to preserve fertility.

**Materials and Method**

The incidence of adnexal torsion was retrospectively analysed in 1007 patients (1411 fresh embryo transfer cycles) who attended our private IVF centre between January 2006 and April 2011. A questionnaire was used to investigate the course and outcome of the pregnancy in 571 clinical pregnancies (pregnancy rate per embryo transfer 40.5%) including any maternal complications. The data of 461 births (birth rate 32.7%) after ART was collected. Adnexal torsion occurred in 5 cases and each case is presented below.

**Case Reports**

**Case 1**

A 35-year-old woman was stimulated prior to undergoing her 1st ICSI treatment which she required because of asthenozoospermia of her partner. Pituitary down-regulation consisted of long protocol (LP) with a GnRH agonist (GnRHa) (triptorelin 0.1 mg/d subcutaneously), starting at the midluteal phase. For COH, 225 IE of human menopausal gonadotropin (hMG) was injected daily intramuscularly until the largest follicle cohort had a diameter of 18–20 mm. Ovulation was induced with 10 000 IE human chorion gonadotropin (hCG). Five mature oocytes were retrieved 35 hours after ovulation by transvaginal puncture and were fertilised. Two blastocysts were transferred. After a positive urine pregnancy test, the presence of an intact singleton pregnancy was recorded in the 6th gestational week (GW).

In the 10th GW the patient suddenly presented with strong abdominal pain over 24 hours and leukocytosis. The left ovary was enlarged, measuring 64 mm (right ovary 34 mm). Laparoscopy confirmed torsion of the left ovary, which was subsequently derotated. The patient was delivered vaginally of a healthy girl (3175 g, 46 cm) born in the 41st GW.

**Case 2**

A 24-year-old woman with polycystic ovarian syndrome (PCOS), hyperandrogenaemia, and protein S deficit had had 2 miscarriages in an earlier relationship. Her new partner had grade III oligo-asthenoteratozoospermia syndrome (OAT), making ICSI treatment necessary. Stimulation was done with a GnRHa LP (triptorelin 0.1 mg) and HMG 150 IE daily, together with metformin tablets 1000 mg and prednisolone tablets 5 mg daily. Eleven metaphase II oocytes were treated by intracytoplasmic morphologically selected sperm injection (IMSI). Fertilisation was confirmed in 7 oocytes. Two blastocysts were transferred, but further cryoconservation was not possible. In the 6th GW the patient presented with persistent abdominal pain and nausea and increased β-HCG levels. Sonographically the ovaries were found to be enlarged, measuring 72 and 67 mm, respectively. Laparoscopy confirmed torsion of the right ovary, which was subsequently derotated. The patient was delivered vaginally of a healthy girl (3175 g, 46 cm) born in the 41st GW.

**Case 3**

The husband of a 40-year-old patient had undergone thyroidec- tomy followed by postoperative radiation therapy 16 years previously for thyroid carcinoma. He subsequently had OAT syndrome. Stimulation of the patient was done in accordance with a GnRHa LP (triptorelin 0.1 mg) and HMG 300 IE daily. Six of 8 mature oocytes could be fertilised and cultivated until the blastocyst stage. Two blastocysts were transferred. In the 5th GW the patient presented with strong abdominal pain and increased β–HCG levels. Sonography showed polycystic ovaries (right side 57 mm, left side 52 mm). Laparoscopy was indicated as the pain was resistant to analgesia. Both ovaries were enlarged, the right one showed livid discolouration and pelvic peritoneal adhesions. The right ovary was derotated and recovered quickly. Postoperative Doppler ultrasound was unremarkable. In the 10th GW, curettage was required for missed abortion. Eleven months later the patient was delivered of a healthy boy.

**Case 4**

A 31-year-old woman underwent IMSI because of asthenoteratozoospermia of her partner. Ten mature oocytes were retrieved after stimulation in accordance with GnRHa LP (triptorelin 0.1 mg) and HMG stimulation 150 IE daily. Nine oocytes could be fertilised and 1 blastocyst was transferred. Four more blastocysts were cryoconserved. After a positive urine pregnancy test, the patient underwent ultrasound examination for abdominal pain and tympanites. Ultrasound showed enlargement of both ovaries (175 mm on the right, 75 mm on the left), a 6-cm left-sided ovarian cyst, free intra-abdominal fluid and an eccentrically located, gestational sac. At this point no surgical intervention was required. In the 8th GW the pain suddenly returned and the torsed right ovary was derotated laparoscopically. In the 19th GW the patient opted for induced abortion because sonography findings showed sirenomenia.
Case 5
IMSI was indicated in a 34-year-old woman due to asthenoteratozoosperma of her partner. Stimulation was done in accordance with a GnRHa LP (triptorelin 0.1 mg) and HMG 225 IE. Eight mature oocytes could be fertilised, 1 blastocyst was transferred, and 2 further blastocysts were cryoconserved. In the 10th GW, the patient suddenly presented with acute abdominal pain. On ultrasound the ovaries were found to be enlarged (68 mm and 48 mm, respectively). Torsion of the right adnexa was found on subsequent laparoscopy. The torsed ovary had ruptured, resulting in bleeding with hemoperitoneum. The adnexa was derotated, coagulation was used to stop the bleeding, and the hemoperitoneum was suctioned off. The adnexa could be preserved and subsequent ultrasound control found the pregnancy to be intact. The subsequent course of the patient’s pregnancy was uncomplicated with the exception of gestational diabetes after GW 30. The patient was delivered of a healthy boy weighing 4090 g in the 40th GW.

Discussion

Incidence
The reported incidence of adnexal torsion is 2.3% in nonpregnant women and 16% in pregnant women [2]. Adnexal torsion rarely occurs in spontaneous pregnancies (1–5 torsions per 10 000 pregnancies). However, 12–25% of all adnexal torsions occur in pregnant women, often in combination with assisted reproduction and its complications (OHSS). The reported incidence is low for oocyte donation cycles (0–0.2%) and IVF cycles (0–0.13%); however, the incidence increased to 6% under stimulation for ART and to 16% with OHSS [2–6]. But even when adnexal torsion occurs simultaneously with OHSS, the reported incidence varies between 1 and 33% [7], 70% of torsions occur in multiple pregnancies [8]. The incidence in our study period with 1411 fresh embryo transfers was 0.35%; however, all 5 cases in our study were singleton pregnancies (5/461 births = incidence of 1.08% per birth after IVF/ICSI) and 2 patients additionally presented with mild OHSS.

Time of occurrence
The majority of adnexal torsions occur in the 1st or 2nd trimester of pregnancy and only around 10% occur in the 3rd trimester [2, 10]. If cysts are found in pregnant women on sonography, these vary rarely (3.8%) result in torsion [6]. According to Mashiach et al., the incidence for both ovaries is approximately the same [2]. In all 5 cases from our ART collective, torsion occurred in pregnant women between the 5th and 10th GW, with 4 torsions found on the right side and 1 on the left side.

Diagnosis
Symptoms and laboratory parameters
The diagnosis of adnexal torsion is difficult if OHSS is also present because the symptoms are not specific. But late diagnosis increases the risk of having to excise the affected organ. Abdominal pain, nausea and vomiting are often suspicious for torsion. Acute abdominal pain occurs in more than 80% of cases, often starting suddenly at night and persisting for more than 24 hours [2, 9, 10, 12]. Several authors have reported that patients had mild leukocytosis; however, while levels may be increased in nonpregnant women, levels may be within normal ranges for pregnant women [7, 9, 12]. Leukocytosis is also one of the laboratory indicators which may change with OHSS.

Ultrasound diagnosis
Transvaginal ultrasound may often show enlargement of the ovaries and polycystic changes without this being evidence of torsion. A pathological result of Doppler flow ultrasound may indicate adnexal torsion, but even normal Doppler findings cannot exclude the possibility of torsion. The rate of false-negative Doppler flow results is considerable, with a reported rate of 61% for pregnant women and 45% for nonpregnant women [11]. Hasson et al. therefore recommended not to base the decision for surgical evaluation only on the results of Doppler flow investigation (as proposed by Arena et al.) but also to take the patient’s past medical history, clinical appearance, and laboratory assessment into account [11, 12]. The differential diagnosis, particularly for right-sided adnexal torsion, includes appendicitis, renal colic, renal or urethral calculus, and obstructive bowel disease [12]. In all cases in our study, acute abdominal pain or gradually increasing pain, mostly accompanied by enlarged polycystic ovaries, led to the patient being admitted to hospital. The size of the ovary on the affected side in our patients ranged between 57 and 175 mm (mean 87.2 mm; Table 1).

Time between hospital admission and surgery
In the literature, the time between admission to hospital and surgery is between 6 and 15.5 hours and may be even significantly shorter in the 1st trimester of pregnancy. However, several days may pass between the start of symptoms and surgery [2, 13]. In our cases, acute symptoms or persistence of complaint meant that the mean time to laparoscopic evaluation and treatment was 6.4 hours (1–24 hours), and treatment was still in time to preserve fertility (Table 1).

Treatment
Laparoscopic derotation of adnexal torsion is recommended as the first-line treatment, even for ovaries which are already ischaemic, because in 73% of cases derotation is sufficient to preserve ovarian function. For Arena et al., complete absence of blood flow in the ovarian vessels is an indication for adnexectomy [12]. We were able to avoid adnexectomy in all cases and were therefore able to preserve fertility.

Risk of recurrence
Laparoscopic fixation of the adnexa (ovariopexy) or shortening of the utero-ovarian ligament can be done to avoid recurrence of adnexal torsion, but this should be the exception rather than the rule [7, 14–16]. In their retrospective case control study, Hasson et al. reported a recurrence rate of 19.5% for pregnant women and 9.1% for nonpregnant women; however 73.2% of pregnant women and 20.8% of nonpregnant women had been treated with ART prior to torsion [11, 17]. None of the 5 cases in our study experienced recurrence during the subsequent course of their pregnancy.

Outcome
Smith et al. reported a reduced fertilisation rate (FR) of 40% for oocytes aspirated from a derotated ovary, while the FR for the unaffected ovary was 93%. 75% of oocytes from the unaffected side and 64% of oocytes from the affected side developed into blasto-
cysts. A reduced FR had been previously described in earlier reports in connection with reduced flow in the ovarian artery [18]. In a repeat IVF procedure, Oelsner et al. retrieved oocytes from laparoscopically derotated ovaries in 6 patients and these oocytes could be subsequently fertilised; Oelsner et al. therefore recommended derotation as the procedure of choice for ischaemic ovaries [19]. The subsequent course of a pregnancy after treatment for adnexal torsion is generally favourable; abortion rates of between 8.3% and 16.6% do not appear to be increased [2,11]. In our cases, 3 pregnancies continued to term with the vaginal delivery of healthy children. One pregnancy was terminated in the 19th GW for medical reasons as ultrasound showed sirenomelia. There was 1 case of missed abortion in a 40-year-old patient; however 11 months later this patient gave birth to a healthy child.

**Conclusion**

Adnexal torsion after ART is not uncommon, particular if accompanied by OHSS and/or (multiple) pregnancy. Adnexal torsion should be kept in mind in patients presenting with acute abdominal pain, nausea, vomiting and sonographically enlarged, polycystic ovaries. The differential diagnosis is difficult, particularly if OHSS is present, and consultation with a reproductive physician should be considered. Laparoscopic investigation and primary derotation should be attempted, even in cases where the organ is already livid and discoloured and Doppler flow is absent. In most cases it will be possible to preserve the affected adnexa and thus preserve fertility.

**Conflict of Interest**

The authors declare that they have no financial connections to any company cited in this article.

**References**


**Table 1** Summary of 5 cases with adnexal torsion after COH and ET.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>RO</th>
<th>TE</th>
<th>PR</th>
<th>OHSS</th>
<th>GW</th>
<th>US: right ovary</th>
<th>US: left ovary</th>
<th>Adm.-OP</th>
<th>Diagnosis</th>
<th>Treatment</th>
<th>Outcome of PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>5</td>
<td>2</td>
<td>yes</td>
<td>mild</td>
<td>10</td>
<td>38</td>
<td>64</td>
<td>24</td>
<td>left adnexal torsion</td>
<td>laparoscopic detorsion + puncture of ovarian cyst</td>
<td>vaginal delivery, 39th GW, boy (2 860 g, 51 cm)</td>
</tr>
<tr>
<td>24</td>
<td>15</td>
<td>2</td>
<td>yes</td>
<td>no</td>
<td>6</td>
<td>72</td>
<td>67</td>
<td>1</td>
<td>right ovarian torsion</td>
<td>laparoscopic detorsion</td>
<td>vaginal delivery, 41st GW, girl (3 175 g, 46 cm)</td>
</tr>
<tr>
<td>40</td>
<td>8</td>
<td>2</td>
<td>yes</td>
<td>no</td>
<td>5</td>
<td>57</td>
<td>52</td>
<td>2</td>
<td>right ovarian torsion</td>
<td>laparoscopic detorsion</td>
<td>missed abortion, 10th GW, curettage</td>
</tr>
<tr>
<td>31</td>
<td>13</td>
<td>1</td>
<td>yes</td>
<td>mild</td>
<td>5</td>
<td>175</td>
<td>75</td>
<td>3</td>
<td>left ovarian cyst (6 cm)</td>
<td>conservative laparoscopic detorsion</td>
<td>induced abortion, 19th GW, sirenomelia</td>
</tr>
<tr>
<td>34</td>
<td>8</td>
<td>1</td>
<td>yes</td>
<td>no</td>
<td>10</td>
<td>68</td>
<td>48</td>
<td>2</td>
<td>right adnexal torsion, ovarian rupture, hema-toperitoneum</td>
<td>laparoscopic detorsion + coagulation and suction</td>
<td>vaginal delivery, 40th GW, boy (4 090 g, 56 cm)</td>
</tr>
</tbody>
</table>

RO = number of retrieved oocytes, TE = number of transferred embryos (blastocysts), PR = pregnancy, OHSS = ovarian hyperstimulation syndrome, GW = gestational week at diagnosis, US = ultrasound, * = diameter (mm), Adm.-OP = time between admission to hospital and surgery (hours)
18 Smith LP, Oskowitz SP, Barrett B et al. IVF and embryo development subsequent to ovarian torsion occurring during the resumption of meiosis. Reproductive BioMedicine Online 2010; 21: 418–421

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