Different sperm sources and parameters can influence intracytoplasmic sperm injection outcomes before embryo implantation*

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Received July 6, 2011; Revision accepted Sept. 27, 2011; Crosschecked Dec. 8, 2011

Abstract: To evaluate the effects of sperm with different parameters and sources on the outcomes of intracytoplasmic sperm injection (ICSI), 1972 ICSI cycles were analyzed retrospectively. Groups 1 to 5 were composed of cycles using ejaculated sperm and were grouped according to sperm quantity, quality, and morphology into normal (288 cycles), or mild (329 cycles), moderate (522 cycles), severe (332 cycles), and extremely severe (171 cycles) oligozoospermia and/or asthenozoospermia and/or teratozoospermia (OAT) groups. Group 6 was composed of 250 cycles using testicular or epididymal sperm, and Group 7 consisted of 80 cycles using frozen-thawed sperm. We found that fertilization rates were gradually reduced from Groups 1 to 6, and reached statistical difference in Groups 5 and 6 (P<0.05). The high-quality embryo rate was higher in Group 1 than in Groups 2, 3, 5, 6, and 7 (P<0.05). No statistical differences were observed in the rates of embryo cleavage, clinical pregnancy, miscarriage, live-birth, premature birth, low birth weight, weeks of premature birth, average birth weight, or sex ratio for all seven groups (P>0.05). A total of nine cases of malformation were observed, with a malformation rate of 1.25% (9/719). In conclusion, different sperm sources and parameters can affect ICSI outcomes before embryo implantation. A full assessment of offspring malformation will require further study using a larger sample size.

Key words: Intracytoplasmic sperm injection (ICSI), Sperm, Sperm source, Sperm parameters, Malformation

1 Introduction

Intracytoplasmic sperm injection (ICSI), first introduced by Palermo et al. (1992), is an assisted-fertilization micromanipulation technique for fertilizing an egg by directly injecting a selected sperm into the ooplasm. Compared with conventional in-vitro fertilization (IVF), ICSI greatly reduces the requirements for sperm quantity, motility, and fertilization ability. With the development of micromanipulation, ICSI has become an important part of assisted reproductive techniques (ARTs) for the treatment of cases with male factor infertility (Sarkar, 2007). With ICSI, an egg can be fertilized not only with fresh sperm with mild or moderate abnormalities but also with sperm following a frozen-thawed procedure, sperm of a severely or extremely severely abnormal concentration, motility or morphology, or even sperm that have been surgically retrieved from
the epididymis or testis (van Steirteghem et al., 1993; Devroey et al., 1994; Redgment et al., 1994; Tournaye et al., 1994; Chen et al., 1996).

Nevertheless, sperm retrieved from the testis, epididymis or ejaculation may have a different concentration, motility or morphology and differ in their degree of maturity, chromosomal or DNA composition, and gene imprinting conditions (Holt and North, 1991; Holt et al., 1992; Giraud et al., 2000; Chatterjee and Gagnon, 2001; Pegg, 2002; Chohan et al., 2004; Liu et al., 2004; Derijck et al., 2007; Kobayashi et al., 2007). For instance, rates of DNA fragmentation, mitochondrial dysfunction, and chromosomal aneuploidy are significantly higher in the sperm of oligozoospermia and/or asthenozoospermia and/or teratozoospermia (OAT) males compared with unaffected controls (Liu et al., 2004; Derijck et al., 2007). Furthermore, aberrant DNA methylation of imprinted loci in sperm from oligospermic patients has been reported (Kobayashi et al., 2007). Generally, testicular and epididymal sperm are considered to have a low degree of maturity and a high malformation rate. The accumulated evidence also shows that the process of freezing and thawing sperm could cause damage to the sperm (Holt and North, 1991; Holt et al., 1992; Giraud et al., 2000; Chatterjee and Gagnon, 2001; Pegg, 2002; Chohan et al., 2004). Therefore, the consequences of using these different sources of sperm have attracted a great deal of attention since the first introduction of ICSI. There is an ongoing debate about this question (Bukulmez et al., 2001; Miller and Smith, 2001; Göker et al., 2002; Aoki et al., 2004; Dozortsev et al., 2006; Loutradi et al., 2006; Tepla et al., 2006; Nilsson et al., 2007; Naru et al., 2008; Verza and Esteves, 2008).

Here, we report an analysis of 1972 ICSI cycles to explore the possible relationships between sperm quantity, quality, morphology, source, and the outcomes of ICSI.

2 Materials and methods

2.1 Subjects

A total of 1925 couples who underwent 1972 ICSI cycles from January 2004 to June 2008 in the Center for Reproductive Medicine of the Women’s Hospital, School of Medicine, Zhejiang University, Hangzhou, China were included in this retrospective study. Institutional review board approval and written consents from patients were obtained prior to data collection. In all cycles studied, the tubal factor was identified as the sole cause of female factor infertility, thereby excluding other female factors such as myoma, endometrial polypus, endometriosis, and uterus deformation. Based on the sperm quality and source on the day of ICSI, the subjects were divided into seven groups.

Group 1 was composed of 288 ICSI cycles with normal semen parameters, based on the 5th World Health Organization standard (WHO, 2010) (total sperm number, calculated by sperm concentration×sperm volume, ≥39×10^6 sperm/ml, progressive motility ≥32%, and morphology ≥4% normal forms). In this group, ICSI was performed for patients with failure or low fertilization rates (<30%) in their last IVF cycle, unexplained primary infertility after more than three cycles of failed artificial insemination with the male partner’s sperm, or abnormal results from more than two previous semen analyses. Group 2 was composed of 329 ICSI cycles with mild OAT (total sperm number 20×10^6–39×10^6 sperm/ml, and/or progressive motility 20%–32%, and/or morphology <4% normal forms). Group 3 was composed of 522 ICSI cycles with moderate OAT (total sperm number 10×10^6–20×10^6 sperm/ml, and/or progressive motility 10%–20%). Group 4 was composed of 332 ICSI cycles with severe OAT (total sperm number 1×10^6–10×10^6 sperm/ml, and/or progressive motility 1%–10%). Group 5 was composed of 171 ICSI cycles with extremely severe OAT (total sperm number <1×10^6 sperm/ml, and/or progressive motility <1%). Group 6 was composed of 250 ICSI cycles with obstructive azoospermia (OA) (azoospermia patients with normal serum follicle-stimulating hormone (FSH), testicular volume, and diagnostic biopsy) or difficult ejaculation on the day of IVF, using testicular or epididymal sperm. Group 7 was composed of 80 ICSI cycles using frozen-thawed sperm, in which the main reason for ICSI was that the progressive motility of donated semen was less than 25% after thawing.

2.2 Sperm preparation

Fresh ejaculated semen was collected on the day of oocyte retrieval and left to liquefy for