The evaluation of different functional sperm parameters has become a tool in andrological diagnosis. These assays determine the sperm’s capability to fertilize an oocyte. It also appears that sperm functions and semen parameters are interrelated and interdependent. Therefore, the question arose whether a given laboratory test or a battery of tests can predict the outcome in in vitro fertilization (IVF).

One-hundred and sixty-one patients who underwent an IVF treatment were selected from a database of 4178 patients who had been examined for male infertility 3 months before or after IVF. Sperm concentration, motility, acrosin activity, acrosome reaction, sperm morphology, maternal age, number of transferred embryos, embryo score, fertilization rate and pregnancy rate were determined. In addition, logistic regression models to describe fertilization rate and pregnancy were developed. All the parameters in the models were dichotomized and intra- and interindividual variability of the parameters were assessed. Although the sperm parameters showed good correlations with IVF when correlated separately, the only essential parameter in the multivariate model was morphology. The enormous intra- and interindividual variability of the values was striking. In conclusion, our data indicate that the andrological status at the end of the respective treatment does not necessarily represent the status at the time of IVF. Despite a relatively low correlation coefficient in the logistic regression model, it appears that among the parameters tested, the most reliable parameter to predict fertilization is normal sperm morphology. (Reprod Med Biol 2005; 4: 7–30)

Key words: assisted reproduction, high intra- and interindividual variability, multivariate approach, prediction of outcome of IVF, sperm functions.

INTRODUCTION

Male subfertility is the reason for an unfulfilled wish for children in approximately 50% of childless couples. In Germany alone, the number of andrologically caused childless partnerships amounts to more than 1,500,000. This high incidence of male factor infertility mandates a complete andrological consultation in all male partners of couples consulting for infertility. During recent years, apart from the light microscopical determination of sperm count and morphological malformations, evaluation of functional sperm parameters has become a powerful tool in andrological laboratories. Some of these assays determine biochemical parameters, such as α-glucosidase1,2 or the polymorphonuclear granulocyte (PMN)-elastase3,4 which have been found to be important for sperm function. Most of them, however, determine biological functions of spermatozoa, and consequently the capability to fertilize an oocyte (i.e. motility, membrane integrity, morphology, zona binding, acrosome reaction, acrosin activity, oolemma binding, chromatin condensation or DNA integrity) (Fig. 1). All these parameters repeatedly showed a moderate or strong relationship between fertilization in vitro and pregnancy when they were examined in spermatozoa from the ejaculate, which was used for IVF treatment, at the same time. In this present review, the impact of these functional sperm parameters shall first be discussed separately and then in a multivariate approach.

In addition, the occurrence of leukocytes in ejaculates, which physiologically produce large amounts of highly detrimental substances, reactive oxygen species (ROS), is common, even in healthy men not regarded as leukocytospermic (leukocyte count < 1 × 10⁶/mL)3 needs to be considered in order to assess the male fertility potential. There is: (i) still no common agreement on the accurate determination of active leukocytes in
ejaculates, the effect of (ii) ROS; and (iii) leukocytes on human sperm function and male fertility. Currently, no simple solution for these problems is available, especially in view of the high variability of these biological parameters.

Motility

Motility, the most obvious sperm function, is an essential prerequisite for fertilization and conventional methods of assisted reproduction. Under in vivo conditions, potentially fertile spermatozoa separate from immotile spermatozoa, debris and seminal plasma in the female genital tract by active migration through the cervical mucus. During this process, not only progressively motile spermatozoa are selected, but male germ cells also undergo physiological changes called ‘capacitation’, which are fundamental prerequisites for the sperm’s functional competence. With regard to in vitro fertilization (IVF), Acosta et al. reported that even low percentages of motile spermatozoa in the ejaculate did not have a significant negative influence on fertilization in vitro and pregnancy rates. However, it may be possible that motility values less than 10% may represent a problem in IVF. Sukcharoen and Keith concluded that even detailed motility grading and sperm motility after 24 h does not have a practical value in predicting the fertilization outcome in an IVF program. However, Shulman et al. emphasized that none of the standard semen characteristics, such as volume, sperm count or motility, has prognostic value for the outcome after intrauterine insemination. The only parameter that could predict treatment outcome was the percentage of motile spermatozoa after appropriate sperm separation. On principle, Kasai et al. recently confirmed these results. These authors also concluded that there is a close positive relationship between mitochondrial membrane potential and sperm motility. Therefore, these parameters are indicative of the male fertility potential.

For assisted reproduction, motile spermatozoa are normally selected by different methods of sperm separation (i.e. swim-up, glass wool filtration, glass bead column separation, migration-sedimentation, density gradient centrifugation) (for review see Henkel & Schill). Some of these methods can also be employed in cases in which epididymal or testicular spermatozoa were aspirated to be used in IVF or intracytoplasmic sperm injection (ICSI). Since the spermatozoon’s ability to self-propelled movement is closely related with other parameters, such as morphology, this results in an increased percentage of morphologically normal sperm after sperm separation. Therefore, motility is an important sperm parameter that is essential for successful fertilization in an assisted reproduction program. In addition, it is a sign of vitality, and scientists in the IVF laboratory make use of this feature to identify viable spermatozoa for ICSI. However, one must approach each male patient as an individual and assisted reproduction laboratories must have different separation techniques available in order to obtain the best result.

Morphology

Sperm morphology, as evaluated by strict criteria, is one of the most important parameters of the standard semen analysis and has repeatedly been proven a good predictor for fertilization in vivo and assisted reproduction. In contrast to the evaluation of the other functional parameters of spermatozoa, morphology is a simple and cost-effective method that can be performed in every andrological and IVF laboratory after thorough training. In this context, it is also important to mention that sperm morphology also correlates significantly with sperm motility and its ability to bind to the zona pellucida (ZP). Liu and Baker, and Menkveld et al. demonstrated that normal sperm acrosomal morphology correlated significantly with sperm binding to the ZP, while Franken et al. and Menkveld et al. showed a strong relationship between normal sperm morphology and the inducibility of the acrosome reaction.