Influence of the number of motile spermatozoa inseminated and of their morphology on the success of intrauterine insemination

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BACKGROUND: Although intrauterine insemination (IUI) is one of the most common assisted reproductive technology methods in the world, the relative influence of various semen characteristics on the likelihood of a successful outcome is controversial. The aim of our study was to assess the results of IUI as a function of both the number of motile spermatozoa inseminated (NMSI) and the percentage of morphologically normal spermatozoa after preparation. METHODS: This was a retrospective study of 889 couples who underwent 2564 IUI cycles of ovarian stimulation with HMG or recombinant FSH in our centre between January 1991 and December 2000. RESULTS: A total of 331 clinical pregnancies were obtained, for a pregnancy rate/cycle of 12.91%. When the NMSI was <13106, the pregnancy rate/cycle was significantly lower (3.13%) than in any of the subgroups with NMSI ≥3106. Sperm morphology, assessed before or after preparation, was not in itself a significant factor that affected the likelihood of IUI success. Nonetheless, when the post-migration rate of normal sperm was <30%, the pregnancy rate/cycle was 5.43% when NMSI was <53106 and 18.42% when NMSI was ≥53106 (P = 0.008). Pregnancy rates did not differ significantly according to NMSI when the percentage of normal sperm after preparation was ≥30%, or according to percentage of normal sperm when the NMSI was ≥53106. CONCLUSIONS: Our results show that a minimum of 53106 motile spermatozoa should be inseminated when the normal morphology of the sperm after preparation is <30%; the quantity compensates at least in part for the defective quality. If this threshold of NMSI cannot be obtained, IVF should be recommended.

Key words: intrauterine insemination/number of motile spermatozoa inseminated/sperm morphology/sperm preparation

Introduction

Intrauterine insemination (IUI) is a method of assisted reproductive technology (ART) recognized to be effective and inexpensive and to entail relatively few restrictions. Nonetheless, the couple should be directed towards a ‘heavyweight’ ART, i.e. IVF or ICSI, when the number of sperm or percentage of morphologically normal sperm (or both) do not attain a certain threshold value. What those values are, however, is unclear.

The prognosis value of the initial semen characteristics in assessing the likelihood of successful IUI is still the subject of debate (Horvath et al., 1989; Lelannou, 1994; Ombelet et al., 1995; Wainer et al., 1996; Branigan et al., 1999; Duran et al., 2002), and studies on the impact of sperm morphology, before and after preparation, have led to divergent results (Francavilla et al., 1990; Matorras et al., 1995; Dickey et al., 1999; Hauser et al., 2001). The minimum recommended number of motile spermatozoa inseminated (NMSI) after preparation varies from 0.8 to 10 × 106, depending on the study (Horvath et al., 1989; Dodson and Haney, 1991; Wainer et al., 1996; Berg et al., 1997; Van Voorhis et al., 2001; Miller et al., 2002). At lower values, IVF should be used.

The aim of our study was to assess the likelihood of IUI success as a function of the NMSI and of the percentage of morphologically normal spermatozoa, assessed after sperm preparation.

Materials and methods

From January 1991 to December 2000, 889 couples completed 2564 IUI cycles in the ART Department of the Poissy-Saint Germain...
Hospital. All these couples had been trying unsuccessfully to conceive for a minimum of 2 years before being treated in our centre. Testing for the women included at least: basal temperature chart, post-coital tests, hormone levels [on day 3, FSH, LH, estradiol (E2) and prolactinemia; on day 22, progesterone] and a hysterosgram. If either the hysterosgram or vaginal ultrasonography suggested peritoneal adhesion or endometriosis, a laparoscopy was performed before any treatment. Men had at least two semen analyses and microbiological tests before any treatment. Serological tests [syphilis, HIV, hepatitis B virus (HBV), HCV] were conducted for both members of the couple. Additional testing depended on any abnormalities observed.

Indications for IUI included cervical and male factors, as well as unexplained infertility. Cervical factors were defined by a negative post-coital test with no sperm abnormalities. Normal semen analyses were defined by the threshold values of the WHO (1992) (concentration ≥ 20 × 10^6/ml, total count ≥ 40 × 10^6, progressive motility ≥ 50%, typical morphology ≥ 30%). The same three observers performed these microscopic analyses throughout the 10 years of the study. All semen samples were collected in the laboratory after 3–5 days of sexual abstinence. After liquefaction for 30 min at room temperature, volume, pH, sperm count and progressive motility were evaluated according to the WHO standard criteria. Sperm concentration was determined with a haemocytometer on two separate preparations of the semen sample (dilution 1:20 in Ringer solution). Sperm motility was determined by assessing at least five microscopic fields to classify at least 200 spermatozoa (×400 magnification). The motility was graded progressive, non-progressive or immotile.

Motile sperm were selected by: (i) a swim-up procedure from 1991 to 1994; (ii) a two-step Percoll gradient (45% and 90%) from 1995 to 1997; and (iii) a two-step Percoll gradient from 1998 to 2000. In all cases, the motile sperm fraction was washed twice by centrifugation and the sperm pellet was resuspended in 0.35 ml of a capacitating medium. The following capacitating media were used successively: B2 (CCD, Paris France) from January 1991 to April 1997, Ferticult (Fertipro, Beernem, Belgium) from May 1997 to January 1999, B2 modified (CCD) from February 1999 to March 2000, and P1 (Irvine Scientific, Santa Ana, CA, USA) from April 2000 to December 2000. No medium was supplemented with albumin.

Sperm were then counted and progressive motility assessed to determine the total NMSI.

To analyse sperm morphology, smears were prepared from the whole ejaculated fraction and from the motile selected one. We used Schorr and Harris’ haematoxylin staining procedure. The percentages of morphologically normal spermatozoa and of various sperm abnormalities were evaluated on 100 sperm at a final magnification of ×1000, according to the method described by David et al. (1975) and modified by Jouannet et al. (1988).

All IUI cycles were accompanied by ovarian stimulation with HMG or recombinant FSH. Ovarian response was monitored by plasma E2 and LH concentrations and by ovarian ultrasonography. In the absence of spontaneous LH peaks, ovulation was induced by injection of 5000 IU HCG. The IUI was performed with a Frydman catheter (CCD) 40 ± 4 h after HCG injection. In the presence of spontaneous LH peak the IUI was performed the next day. The patient received 300 mg/day of intravaginal micronized progesterone during the luteal phase until the day of b-HCG testing. The principal assessment criterion was the clinical pregnancy rate/cycle, according to semen characteristics. A clinical pregnancy was defined as a pregnancy that was b-HCG-positive and had a gestational sac visible with ultrasonography.

### Statistical analysis

A global x^2-test was calculated for all population groups according to each set of criteria studied, to determine whether there was a statistically significant difference between the subgroups. Then a 2 × 2 comparative x^2-test was carried out. A P-value < 0.05 was considered significant. The cumulative rate curves were compared using the log rank test. We used the Cox model to examine the contribution of the independent variables.

### Results

The mean age of the women at IUI was 32.3 ± 4.2 years (range 21–44 years).

The distribution of the different indications for IUI were: male factor subfertility 62.32% (n = 554 couples), cervical factor infertility 16.98% (n = 151 couples) and unexplained infertility 20.70% (n = 184 couples).

The following sperm abnormalities, defined according to the WHO criteria, were observed: isolated oligospermia 5% (n = 28), isolated asthenospermia 48% (n = 265), isolated teratospermia 5% (n = 28), oligoasthenospermia 14% (n = 75), oligoteratospermia 2% (n = 12), asthenoteratospermia 16% (n = 88) and oligoasthenoteratospermia 10% (n = 57).

Three hundred and thirty-one clinical pregnancies followed 2564 IUI cycles, for a clinical pregnancy rate/cycle of 12.91% and a clinical pregnancy rate/couple of 37%.

Fifty-three clinical pregnancies ended in spontaneous abortions (abortion rate 16%). There were 55 multiple pregnancies: 42 twins, 10 sets of triplets and three sets of quadruplets (multiple pregnancy rate 16.6%).

Of the couples with cervical factor infertility, 41.7% became pregnant (63 pregnancies for 151 couples). The cumulative pregnancy rate/couple was 38.4% (213 pregnancies for 554 couples) for those with male factor subfertility and 30% (55 pregnancies for 184 couples) for those with unexplained infertility.

Table I shows the clinical pregnancy rate/cycle as a function of the NMSI. When the NMSI was < 1 × 10^6 in our series, the clinical pregnancy rate/cycle was 3.13%, significantly lower than in the subgroups with a NMSI ≥ 2 × 10^6 (P < 0.01). The best pregnancy rate/cycle (14.75%) was obtained for NMSI between 5 and 10 × 10^6, but this rate did not differ significantly from those of any of the subgroups with a NMSI ≥ 2 × 10^6.

Looking at the clinical pregnancy rates according to women’s age (Table II) shows better results for patients < 25 years old, but there were only 56 such cycles. The pregnancy rates/cycle were similar for the four age groups between 25 and 40 years. In particular, we noted that the 210 cycles in patients aged between 38 and 40 years resulted in a satisfactory pregnancy rate of 15.24%. The pregnancy rate for women ≥ 40 years old, however, plummeted to 5.04%.

We studied the cumulative clinical pregnancy rate of two populations of couples. In group A the NMSI was always < 5 × 10^6, regardless of the number of attempts (Table III). In group B the NMSI was always ≥ 5 × 10^6 (Table IV).

Only 36% of the couples in group A (who continued IUI for as many as five cycles) obtained a clinical pregnancy, compared with 69% of the couples of the group B. The clinical...
pregnancy rates/cycle were not significantly different between the first and second attempts in group A and B (13.24% compared with 17.18%; \( P = 0.16 \)), but did differ significantly for the third, fourth and fifth attempts (3.75% versus 10.66%; \( P = 0.05 \)). Figure 1 shows the curves for cumulative clinical pregnancy rates for these two groups (log rank test \( P = 0.11 \); Cox model \( P = 0.9 \); variables examined: NMSI and women’s age).

We also studied the clinical pregnancy rate/cycle according to the percentage of normal sperm before preparation. These rates were quite similar, both when the global sperm morphology was excellent (normal sperm rate \( \geq 70\% \), pregnancy rate 12.69%) and when it was very poor (normal sperm rate \( \leq 20\% \), pregnancy rate 15.08%). The same is true for the abnormal acrosomal characteristics when considered alone. Accordingly, the clinical pregnancy rate was 10.38% (33 clinical pregnancies in 318 cycles) when the rate of normal acrosomes exceeded 80%, and 9.80% (10 clinical pregnancies in 102 cycles) when the rate of normal acrosomes was below 30% (not significant).

Sperm morphology was studied after preparation only from January 1992 onwards. We thus studied 2238 cycles and found that even when the post-preparation normal sperm rate was \( \leq 30\% \), the clinical pregnancy rate/cycle was 11.31%, which was not significantly different from the pregnancy rates observed with higher percentages of normal sperm.

Table VI shows the clinical pregnancy rates/cycle according to the NMSI and the percentage of normal spermatozoa after sperm preparation. For a normal morphology sperm rate \( < 30\% \) after preparation, the clinical pregnancy rate was 5.43% (5/92) when the NMSI was \( \leq 10^6 \) and 18.42% (14/76) when the NMSI was \( \geq 5 \times 10^6 \). This difference is statistically significant (\( P = 0.008 \)). On the other hand, when the percentage of normal sperm was \( \geq 30\% \), pregnancy rates did not differ significantly, regardless of the NSMI. Similarly, when the NMSI was \( \geq 5 \times 10^6 \), the pregnancy rates did not differ regardless of the percentage of normal sperm. In all, 104 IUI cycles were performed with a normal sperm rate after migration of between 20% and 30%, and nine clinical pregnancies occurred (pregnancy rate/cycle 8.65%).

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### Table I. Rate of clinical pregnancies/cycle depending on the NMSI

<table>
<thead>
<tr>
<th>Group</th>
<th>NMSI (x10⁶)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n &lt; 1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Cycles</td>
<td></td>
<td>96</td>
<td>173</td>
<td>471</td>
<td>1119</td>
<td>705</td>
<td>2564</td>
</tr>
<tr>
<td></td>
<td>n ≥ 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% pregnancies/cycle</td>
<td>3.13%</td>
<td>8.67%</td>
<td>11.89%</td>
<td>14.75%</td>
<td>13.05%</td>
<td>12.91%</td>
</tr>
</tbody>
</table>

Global \( \chi^2 = 14.74; df = 4; P = 0.005 \). In the 2 × 2 comparison: group 1 was significantly different from group 3 (\( \chi^2 = 6.57; P = 0.01 \)); group 1 was significantly different from group 4 (\( \chi^2 = 10.02; P = 0.002 \)); group 1 was significantly different from group 5 (\( \chi^2 = 7.96; P = 0.005 \)); and group 2 was significantly different from group 4 (\( \chi^2 = 4.61; P = 0.03 \)).

### Table II. Rate of clinical pregnancies/cycle according to the age of the women at the time of the first IUI

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A &lt; 25</td>
<td>56</td>
<td>12(21.43)</td>
</tr>
<tr>
<td>25 ≤ A &lt; 30</td>
<td>665</td>
<td>86 (12.93)</td>
</tr>
<tr>
<td>30 ≤ A &lt; 35</td>
<td>1072</td>
<td>145 (13.53)</td>
</tr>
<tr>
<td>35 ≤ A &lt; 38</td>
<td>442</td>
<td>50 (11.31)</td>
</tr>
<tr>
<td>38 ≤ A &lt; 40</td>
<td>210</td>
<td>32 (15.24)</td>
</tr>
<tr>
<td>40 ≤ A</td>
<td>119</td>
<td>6 (5.04)</td>
</tr>
<tr>
<td>Total</td>
<td>2564</td>
<td>331</td>
</tr>
</tbody>
</table>

Global \( \chi^2 = 12.54; df = 5; P = 0.03 \). In the 2 × 2 comparison: group 6 was significantly different from group 1 (\( \chi^2 = 11.08; P = 0.0099 \)); group 6 was significantly different from group 2 (\( \chi^2 = 6.08; P = 0.01 \)); group 6 was significantly different from group 3 (\( \chi^2 = 6.96; P = 0.008 \)); group 6 was significantly different from group 4 (\( \chi^2 = 4.10; P = 0.04 \)); group 6 was significantly different from group 5 (\( \chi^2 = 7.72; P = 0.005 \)); and group 6 was significantly different from group 4 (\( \chi^2 = 4.67; P = 0.03 \)).

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### Table III. Cumulative clinical pregnancy rate in group A couples with NMSI always \( \leq 5 \times 10^6 \) during IUI

<table>
<thead>
<tr>
<th>Range</th>
<th>Abandoned</th>
<th>Total</th>
<th>No pregnancy</th>
<th>Clinical pregnancy ( n % )</th>
<th>Cumulative clinical pregnancy rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140</td>
<td>267</td>
<td>122</td>
<td>18 (13)</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>114</td>
<td>68</td>
<td>11 (14)</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
<td>191</td>
<td>43</td>
<td>2 (5)</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>23</td>
<td>1 (4)</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>23</td>
<td>11</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>299</td>
<td>267</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

### Table IV. Cumulative clinical pregnancy rate in group B couples with NMSI always \( \geq 5 \times 10^6 \) during IUI

<table>
<thead>
<tr>
<th>Range</th>
<th>Abandoned</th>
<th>Total</th>
<th>No pregnancy</th>
<th>Clinical pregnancy ( n % )</th>
<th>Cumulative clinical pregnancy rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>479</td>
<td>506</td>
<td>393</td>
<td>86 (18)</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>330</td>
<td>460</td>
<td>277</td>
<td>53 (16)</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>234</td>
<td>458</td>
<td>209</td>
<td>54 (11)</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>153</td>
<td>296</td>
<td>139</td>
<td>14 (9)</td>
<td>54</td>
</tr>
<tr>
<td>5</td>
<td>54</td>
<td>119</td>
<td>46</td>
<td>8 (15)</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>1250</td>
<td>1064</td>
<td>868</td>
<td>186</td>
<td></td>
</tr>
</tbody>
</table>
Cumulative clinical pregnancy rate according to whether NMSI was \( < 5 \times 10^6 \) or \( \geq 5 \times 10^6 \).

<table>
<thead>
<tr>
<th>NMSI (( \times 10^6 ))</th>
<th>Clinical pregnancy rate/ cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical sperm (&lt; 30%)</td>
</tr>
<tr>
<td>( N &lt; 5 )</td>
<td>Group 1: 5/92 (5.43%)</td>
</tr>
<tr>
<td>( N \geq 5 )</td>
<td>Group 3(^a): 14/76 (18.42%)</td>
</tr>
<tr>
<td>Total</td>
<td>19/168 (11.31%)</td>
</tr>
</tbody>
</table>

Global \( \chi^2 = 8.95; df = 3; P = 0.03 \). In the 2 \( \times 2 \) comparison:
- Group 1 was significantly different from group 3 (\( \chi^2 = 6.99; P = 0.008 \));
- Group 1 was significantly different from group 4 (\( \chi^2 = 5.38; P = 0.02 \)).

Discussion

In our study, 331 clinical pregnancies were achieved after 2564 IUI, for a total clinical pregnancy rate/cycle of 12.91\%. This rate is within the range of previous reports. A review covering 17 publications about IUI with ovarian stimulation by HMG between 1978 and 1995 reported 274 pregnancies in 2223 IUI cycles, for a pregnancy rate/cycle of 12.33\% (Wainer and Merlet, 1998).

With an NMSI \( < 1 \times 10^6 \), the pregnancy rate/cycle was 3.13\%, significantly lower than in the subgroups with an NMSI of \( \geq 2 \times 10^6 \). Most authors agree on this minimum threshold of \( 1 \times 10^6 \) for the NMSI, and recommend IVF when this value is lower (Horvath et al., 1989; Dodson and Haney, 1991; Nulsen et al., 1993; Brachs et al., 1994; Lellouche, 1994; Campana et al., 1996; Huang et al., 1996; Wainer et al., 1996; Berg et al., 1997). Conversely, Burr et al. (1996) found no significant difference between pregnancy rates regardless of the NMSI, but only 35 cycles involved \( < 1 \times 10^6 \) motile spermatozoa.

Other authors have suggested using the total number of motile spermatozoa of the initial sperm count as the criterion for choosing between IUI and IVF, and have recommended threshold values ranging from 5 to \( 10 \times 10^6 \) (Campana et al., 1996; Dickey et al., 1999). The usefulness of this criterion, however, is limited by the variability of quality from one ejaculation to another, as well as the variable results of sperm preparations.

All forms of ART yield very mediocre results for women \( \geq 40 \) years old (Van der Westerlaken et al., 1998). Our results confirm that IUI is no exception, with a clinical pregnancy rate/cycle of 5.04\% for that age group. Many authors therefore suggest that women \( \geq 38 \) years old begin directly or very quickly with IVF. Nonetheless, in our series, \( > 200 \) cycles of IUI in women aged 38 and 39 years led to 32 clinical pregnancies, for a rate/cycle of 15.24\%. This should encourage us not to automatically rule out IUI in this age range; for example, we could offer these patients three IUIs over a maximum period of 6 months before resorting to IVF.

Sperm morphology is another factor besides the patient’s age and the NMSI that may influence the IUI results. Several IVF studies have shown that the fertilization rate decreases with a low level of normal sperm (Kruger et al., 1986; 1988; Oehninger et al., 1988). In a prospective study of 45 couples, Kruger et al. (1988) assessed sperm morphology before preparation. They used two different morphological criteria: percentage of strictly normal forms and the morphological index, which groups the strictly normal spermatozoa and the slightly amorphous forms. The percentage of fertilized oocytes was 7.6\% for men with a strictly normal spermatozoa rate \( < 4\% \) and a morphological index \( < 30\% \). The fertilization rate was at least 63.9\% when the strictly normal spermatozoa rate was \( > 4\% \) and the morphological index \( > 30\% \).

It is thus logical that sperm morphology modifies the results of IUI. Van Waart et al. (2001) conducted a literature review on this subject: only six of 421 studies could be used. The analysis showed a significant improvement in the pregnancy rate above a 4\% threshold for strict criteria. In our study, however, considering sperm morphology only, before or after preparation, did not help to predict IUI results. This was also the case when only the rates of acrosomal abnormalities were considered. Several other retrospective and prospective studies have reached the same conclusions.
(Matorras et al., 1995; Karabinus and Gelety, 1997; Dickey et al., 1999). Conversely, some authors have observed that likelihood of pregnancy with IUI fell when the pre-preparation percentage of normal sperm was low (Francavilla et al., 1990; Toner et al., 1995; Burr et al., 1996; Lindheim et al., 1996; Hauser et al., 2001). The threshold for the percentage of spermatozoa with normal morphology below which IVF is recommended thus varies according to team and technique from 4% to 50%. When the strict criteria of sperm normality (Kruger et al., 1988) were considered, there were fewer than 20 of these couples (i.e. below this threshold) in the population of each series (Toner et al., 1995; Lindheim et al., 1996; Hauser et al., 2001), and no reliable conclusions can be drawn.

These divergent results raise several questions. Which reference criteria should be used to assess sperm morphology (David’s, Kruger’s, or others)? Should a single criterion be considered (for example a percentage <4% of strictly normal spermatozoa) or several criteria (level of strictly normal spermatozoa + morphological index + abnormal acrosomal characteristics, etc.)? The second issue is that morphological assessments may vary substantially according to the conditions of observation. Semen preparation may modify sperm characteristics considerably, and the number of motile spermatozoa and the morphological criteria should logically be assessed after semen preparation. In our study, morphology improved after preparation in nearly three-quarters of the men (125/170) with a rate of normal sperm before preparation <30%: the rate of normal features exceeded the 30% threshold. This result justifies the use of morphology only after preparation for assessing IUI prognosis.

Our study shows that, when morphologically normal sperm account for <30% of a sample after preparation, the NMSI strongly influences the likelihood of successful IUI. An initial semen preparation that reveals this low level of spermatozoa with normal morphology suggests that IUI will involve ≥5 × 10⁶ motile spermatozoa. Ombelet et al. (1997) suggested that the NMSI could compensate for inadequate sperm morphology after observing that morphological scores were significantly lower (<4% of normal forms) in cases of pregnancy failure only in the group with a NMSI <1 × 10⁶. In this study the morphological score was calculated before preparation.

While most teams already offer IVF or even ICSI in cases of very severe teratospermia (<4% normal forms), the initial approach to severe teratospermia (10–30% normal forms) is a more difficult question. Our study shows that IUI is not an unreasonable approach when the NMSI is ≥5 × 10⁶. Our series included 104 cycles when normal forms were between 20% and 30%: there were nine clinical pregnancies (8.65%), with a clinical pregnancy rate ranging from 1.96% for a NMSI <5 × 10⁶ to 15.09% for a NMSI ≥5 × 10⁶. When normal forms accounted for <20%, there were nonetheless 10 pregnancies in 64 cycles, with a pregnancy rate ranging from 9.76% to 26.09%, depending on the NMSI.

A broader study would improve the assessment of the results obtained for the subgroups with normal sperm rates of 20–30%, 10–20% and <10%.

It might also be interesting to calculate the threshold value of motile normal spermatozoa necessary to achieve pregnancy. Such a calculation, however, would require assessing the morphology of the motile spermatozoa in the migrated fraction only, which would be technically difficult.

Severe teratospermi may be associated with oligospermi that makes it impossible to obtain an NMSI ≥5 × 10⁶. A double sperm collection, the day of the IUI, might be realized, since the threshold of 5 × 10⁶ might be reached by combining two semen samples. Future studies should address this question. If this NMSI still cannot be reached, IVF should be recommended.

Overall, our study confirms the efficacy of IUI with gonadotrophin stimulation for a large population. Clinical pregnancy rates are satisfactory, including for patients aged 38 and 39 years old, as long as the NMSI exceeds 1 × 10⁶. Because semen preparation often reduces the level of abnormal sperm, IUI prognosis can best be assessed with the post-preparation morphological characteristics. Our results show that for couples with a rate of normal sperm after preparation <30%, >5 × 10⁶ of motile spermatozoa must be inseminated. If this NMSI threshold cannot be reached, IVF should be recommended to these couples.

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Submitted on April 17, 2004; accepted on June 2, 2004