The Management of Oligospermic Infertility by *in Vitro* Fertilization

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INTRODUCTION

The first infant to be born from a collaborative program of *in vitro* fertilization and embryo transfer (IVF/ET) between the University of Western Australia and PIVET Laboratory was delivered in July 1982.[1] So far 35 infants have been delivered of women treated within the program, which was initially used because of occlusive tubal disease or absent fallopian tubes. More recently the technique has been explored for nontubal causes of infertility, with pregnancies reported in patients treated primarily for pelvic endometriosis,[2] spermatozoal antibodies in the female,[3] and in cases where the husband has reduced spermatozoal motility (including levels below 5 million motile spermatozoa per milliliter) or exhibits a high proportion of abnormal sperm morphology (>60% atypical).[4]

A number of large series have shown that most fertile males have a density greater than 40 million spermatozoa per milliliter of semen.[5-7] However, a consistent correlation with infertility appears to exist only when the concentration falls below 20×10^6 spermatozoa/ml, although absolute infertility cannot be assured even with densities less than 5×10^6 million per milliliter.[8] A major problem in assessing the fertility of males lies in the large intrasubject variability noted in both the number of spermatozoa and the volume of the ejaculate, with consequent variations in the density.[9] However, the proportion of spermatozoa exhibiting good or excellent progressive motility and the range exhibiting normal morphology appear not to change significantly in the individual.[9]

In seeking a precise assessment of the fertilizing potential of spermatozoa, several workers have investigated the penetration of zona-pellucida-free hamster ova by spermatozoa from fertile and infertile males.[10,11] Generally the results have indicated reduced rates of binding and penetration of ova, but the technique is unlikely to provide a conclusive and comprehensive assessment of semen quality since all the factors required for fertilization of zona-intact human oocytes are not present.

In a previous study we have shown that fertilization of human oocytes can be

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achieved *in vitro* for couples whose infertility has been attributed to oligospermia as the sole or major factor and who have failed to conceive by intrauterine insemination using husbands' washed spermatozoa.[4] Pregnancies can be achieved even where the total number of motile spermatozoa is 5 million per milliliter or less (severe oligospermia), although there is a reduced capacity for fertilization. In this study we present a comprehensive analysis of the *in vitro* fertilization rates as a function of spermatozoal density and spermatozoal motility, correlating the findings with additional female factors and unexplained infertility as well as chronic oligospermia.

MATERIALS AND METHODS

During an 8-month period from February to October 1983 a consecutive series of 156 cases reaching the stage of oocyte recovery at laparoscopy were analyzed. The predominant cause of infertility for most couples (117) was for irreparable tubal disease, but additional patients were admitted with endometriosis unresponsive to conventional therapies (14 patients) serum antibodies to spermatozoa in the female (3), oligospermia (6), and unexplained infertility (16). In all patients ovulation was stimulated by clomiphene citrate with or without human menopausal gonadotropin, and oocyte retrieval, fertilization, embryo culture, and embryo transfer were carried out as described previously.[12] Where spermatozoal antibodies were present in the female, deactivated donor serum was substituted for the patient's own serum in the fertilization and culture system. Preliminary semen analysis is carried out on all males during the work-up for IVF and those with densities less than 20×10^6/ml or progressively motile forms less than 12×10^6/ml have three to six samples examined. Mean values are reported in this study. The preparation of spermatozoa is described in detail, as adjustments were made depending upon the quality of semen samples produced on the day of oocyte recovery. We have noted consistently high rates of fertilization when the number of progressively motile spermatozoa within the insemination tube or culture dish containing a single preovulatory oocyte in 1 ml of fertilization medium is within the range of 0.5 to 2.0×10^5 spermatozoa/ml, at which all fertilizations are currently undertaken.

PIVET Laboratory is housed within the theatre suite where oocytes are recovered at laparoscopy. The sperm collection rooms are adjacent to the laboratory and kept warm at 22–24°C. Husbands produce the semen sample within the collection room by masturbation following a minimum of 4 days' abstinence. The sample is placed immediately in a double-door hatchway and a buzzer/light system alerts the laboratory staff, who open their side of the hatch door to receive the semen, which is placed immediately on a reciprocating rocker within an incubator at 37°C. If liquefaction is not complete by 30 minutes, the semen sample is gently "glass-pipetted" 10 to 20 times to break up viscous strands. Semen analysis is then undertaken and spermatozoa are prepared by the overlay technique described by Lopata *et al.*[13] Where the semen analysis demonstrates less than 12 million motile spermatozoa per milliliter, the sample is prepared applying modifications that we have previously described.[4] In brief: between 1 ml and the entire semen sample is diluted in modified Tyrode's solution containing deactivated maternal serum prior to centrifugation at 200 *g* for 15 minutes. After removal of the supernatant, the sperm pellet is resuspended in the total 5 ml of solution for a second wash and centrifugation. The supernatant is again removed, leaving 1 ml in the tube. This is carefully overlayed with 4 ml of fresh fertilization medium and incubated at 37°C for 30 minutes. A small aliquot is taken from the top of the overlay and the concentration analyzed. If $\geq 1 \times 10^6$ motile spermatozoa/ml are

present, a 1-ml portion is removed from the top of the overlay. If the concentration is $<1 \times 10^6$ motile spermatozoa/ml, as is usual with oligospermic samples, the entire overlay is carefully removed and centrifuged at 200 *g* for 10 minutes to concentrate the spermatozoa. After the supernatant is removed, the pellet is resuspended in a volume required to achieve a density around 1×10^6 spermatozoa/ml. An aliquot of 50 to 200 μl of the enriched motile sample is added to each fertilization tube or culture dish to provide a final concentration around the oocyte of between 0. 5 to 2×10^5 motile spermatozoa/ml. If a minimum of 50,000 motile forms could not be achieved within the fertilization tube or culture dish, donor spermatozoa were offered in such cases. All inseminations were undertaken 4 to 8 hours after oocyte recovery and oocytes were examined 16 to 20 hours after insemination after dissection of the coronal coat. Fertilization was confirmed by the presence of two pronuclei in the cytoplasm of the oocytes and where possible, two polar bodies. Oocytes failed to fertilize in 16 patients (10.3%) and in such cases reinsemination was performed, with the findings reported as part of a separate study. Embryo transfers were undertaken 44 to 48 hours after oocyte recovery, when the majority of embryos were at the 4-cell stage. Pregnancies were diagnosed by a rising beta human chorionic gonadotropin concentration 16 days or more after ovum recovery and were confirmed by the ultrasonic detection of an intrauterine gestational sac 4 to 6 weeks after embryo transfer.

All data of fertilization rates have been submitted to χ^2 analysis within 2×2 contingency tables, applying Yates' correction where appropriate.[14] Where groups have been combined for analysis, homogeneity has been confirmed on each occasion. The proportion of motile forms at high and low spermatozoal densities is presented as the value $\pm$ 1 standard error of the mean and was analyzed by Student's *t*-test.

RESULTS

The World Health Organization definition of oligospermia has been applied: it refers to semen samples displaying less than 20 million spermatozoa per milliliter or less than 12 million spermatozoa with good to excellent progressive motility per milliliter (that is, less than 60% of 20 million).[15] FIGURE 1 shows the distribution of patients admitted to an IVF program on the basis of previous semen samples analyzed with reference to the mean values of total density and proportion displaying progressive motility. The majority of semen samples had spermatozoal density >20 million per milliliter, but almost 30% had <20 million motile spermatozoa per milliliter. There was a direct relationship between motility and density of spermatozoa so that the proportion exhibiting progressive motility in the oligospermic group was 45.3 $\pm$ 4.73%, and this was significantly less ($0.001 < p < 0.01$) than normospermic males who had 61.4 $\pm$ 1.56% progressively motile forms.

The fertilization rate and incidence of pregnancies are shown in TABLE 1, in which the data have been analyzed in terms of the preexisting semen profile and additional female factors for all cases. Overall the pregnancy rate in this series was 11. 5% per laparoscopic recovery of oocytes (18/156) or 12.9% of those proceeding to embryo transfer (18/140). Five pregnancies were achieved for 26 couples in whom the husband was known to have chronic oligospermia. The pregnancy rate is not different from that of the normospermic group, but the proportion of oocytes that were successfully fertilized to generate embryos was significantly lower in the oligospermic group ($p < 0.001$). Of additional interest, normospermic cases treated for unexplained infertility also demonstrated a significantly reduced fertilization rate ($p < 0.001$), although pregnancies were similarly achieved. In further analyzing the fertilization rate of

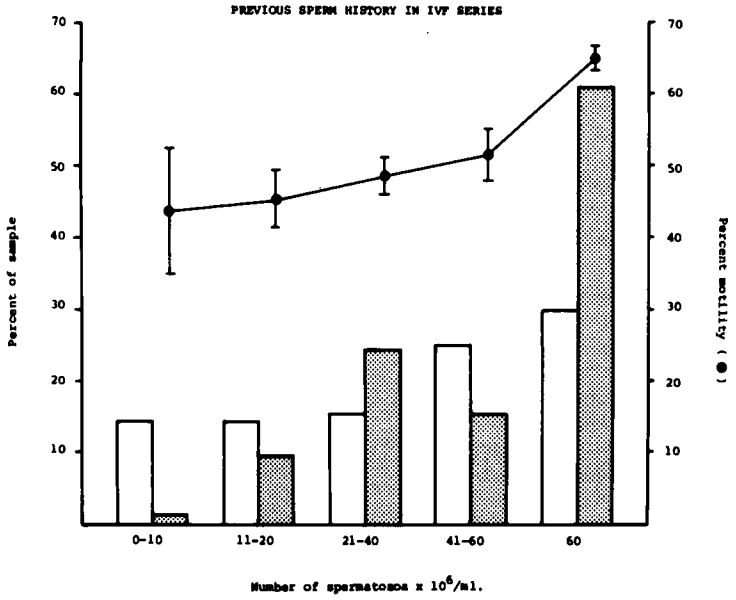

FIGURE 1. Distribution of the total spermatozoal density (*stippled bars*) and motile spermatozoa (*open bars*) per milliliter of semen in 156 consecutive cases admitted for IVF/ET. The mean motile proportion for each group is indicated (●—●).

oocytes (TABLE 2) in relationship to moderate oligospermia (6–12 million motile spermatozoa/ml) and severe oligospermia (1–5 million motile spermatozoa/ml), it was found that the reduced fertilization rate was contained within the severely oligospermic group ($p < 0.001$). Semen samples with 6 million motile spermatozoa or more demonstrated a potential for *in vitro* fertilization similar to that of entirely

TABLE 1. The Fertilization Rate of Human Ova *in Vitro* as a Function of Female-Related Infertility Factors and Oligospermia

Semen Profile	Fertilization Rate: No. of Embryos/No. of Ova (%) {No. of Patients; No. Pregnant}					
	Female Factor					
	Nil	Tubal	Endometriosis	Sperm Antibodies	Unexplained	Total
Oligospermia[a]	5/14 {6; 1}	29/46 {15; 4}	14/24 {5; 0}	—	—	46/84[b] {26; 5}
Normal	—	252/315 {102; 10}	18/19 {9; 0}	7/8 {3; 1}	30/63 {16; 2}	307/405 {130; 13}
Total	5/14 {6; 1}	281/361 {117; 14}	32/43 {14; 0}	7/8 {3; 1}	30/63[c] {16; 2}	355/489 {156; 18}

[a]Oligospermia is defined as mean sperm density of $< 20 \times 10^6$ sperm/ml or concentration of motile sperm of $< 12 \times 10^6$ sperm/ml.

[b]Significantly different from normal group ($p < 0.001$).

[c]Significantly different from patients with tubal factors only ($p < 0.001$).

TABLE 2. Relationship between the History of Oligospermia ($<12 \times 10^6$ Motile Sperm/ml) and the Potential for Successful Fertilization of Human Ova *in Vitro*

Mean No. of Motile Sperm $\times 10^6$/ml	No. of Patients	Fertilization Rate: No. of Embryos/No. of Ova (%)	No. of Patients in Whom Fertilization Failed	No. of Patients Pregnant
1–5	12	14/38 (36.8)[a]	5[a]	2
6–<12	14	33/46 (71.7)	1	3
≥12[b]	102	252/315 (80)	5	10
Total	128	299/393 (76)	11	15

[a]Significantly different from the group with $\geq 6 \times 10^6$ motile sperm/milliliter.

[b]Includes all patients with "tubal-only" factors when there is a mean motile sperm concentration $\geq 12 \times 10^6$ sperm/milliliter.

normospermic samples if the only female factor was tubal. Although the fertilization rate is reduced in the severely oligospermic group, two pregnancies were achieved, and both have resulted in delivery of healthy infants at term. Whereas the data in TABLES 1 and 2 refer to fertilization results related to the previous knowledge of oligospermia, TABLE 3 provides a similar analysis in respect to the semen variables on the day of fertilization set against the previous history of the male. It can be seen that 6 of 26 patients (23%) previously known to be oligospermic presented normal semen samples on the day of oocyte recovery. Conversely, only 4 of 130 cases (3%) previously categorized as normospermic presented oligospermic samples for fertilization. Ana-

TABLE 3. The Effect of Sperm Density of the Semen Sample used for IVF Insemination on the *in Vitro* Fertilization Rate of Human Ova from Oligospermic and Normal Males

Past History (Mean of 6–12 Semen Samples)	Variable (No. of Sperm/ml)	No. of Embryos/No. of Ova (%) {Number of Patients} Sample used for Insemination: Oligospermic[a]	Normal[b]	Total
Oligospermia[a]	Total density $<20 \times 10^6$ Motile sperm $<12 \times 10^6$	10/29 (34%) {12}	8/10 (80%) {3}	18/39 (46%) {15}
	Total density $\geq 20 \times 10^6$ Motile sperm $<12 \times 10^6$	21/33 (63%) {8}	9/12 (75%) {3}	30/45 (66%) {11}
	Total	31/62 (50%) {20}	17/22 (77%) {6}	48/84 (57%)[c] {26}
Normal[b]	—	13/21 (62%) {4}	294/384 (76%) {126}	307/405 (75%) {130}
	Total	44/83 (53%)[c] {24}	311/406 (76%) {132}	355/489 (73%) {56}

[a]Denotes all patients whose sperm density was $<20 \times 10^6$/ml and whose concentration of motile sperm was $<12 \times 10^6$/ml.

[b]Denotes all patients whose sperm density was $\geq 20 \times 10^6$ sperm/ml and whose number of motile sperm was $\geq 12 \times 10^6$/ml.

[c]Significantly different from normal group ($p < 0.001$).

lyzing the oligospermic group more closely, it was found that those with a combined reduction in density and motility had a significantly lower ($0.01 < p < 0.05$) fertilization rate than did those who had normal spermatozoal density, but reduced motility. The difference was noted only in those oligospermic cases who presented oligospermic samples on the day. Overall, such cases demonstrated a reduced fertilization rate ($0.01 < p < 0.05$) compared with that of men who presented normal samples on the day. However, in the overall group classified as oligospermic on previous history, there was no difference in the fertilization rate between the combined (reduced density and reduced motility) group and those classified because of reduced motility. The difference in fertilization rates between the normal and both oligospermic groups was highly significant ($p < 0.001$) whether the comparison was made on the basis of the previous history or from semen samples presented on the day of fertilization.

A further analysis of the fertilization rates for the variable of spermatozoal density was correlated against the proportion of motile spermatozoa in the sample presented

TABLE 4. The Relationship between Sperm Density of Sample Used for Insemination *in Vitro* and Percent of Motility on the Fertilization of Human Ova

Sperm[b] Density (No. $\times 10^6$/ml)	Fertilization Rate: Number of Embryos/No. of Ova (%) {*n*}[a]			
	Percent of Motility[b]			
	<40%	40%–60%	>60%	Total
<20	8/25 (32%) {9}	8/16 (50%)[c] {6}	16/20 (80%) {4}	32/61 (52%)[d] {19}
≥20	52/100 (52%) {27}	66/77 (86%) {28}	205/267 (77%) {82}	323/428 (75%) {137}
Total	60/125 (48%)[c] {36}	74/93 (80%) {34}	221/271 (82%) {86}	355/489 (73%) {156}

[a]Number of patients.

[b]Variables derived from semen sample used for insemination.

[c]Significantly different from group with $>20 \times 10^6$ sperm/ml (40–60% motile); $0.001 < p < 0.01$.

[d]Significantly different from total with $\geq 20 \times 10^6$ sperm/ml; $p < 0.001$.

[e]Significantly different from combined group with ≥40% motile sperm; $p < 0.001$.

for insemination (TABLE 4). The fertilization rate of ova is significantly reduced in the group with less than 20 million spermatozoa per milliliter ($0.001 > p < 0.01$). In comparing the rates as a function of motility, the poorest results were found in those samples with less than 40% progressively motile and was equally reduced in the two groups regardless of spermatozoal density ($p < 0.001$). In the 40–60% motility range a significant reduction in the fertilization rate was only noted for those whose spermatozoal density was also low ($0.01 < p < 0.05$).

In sixteen patients (10%) there was failure of fertilization of all oocytes (TABLE 5). This was not related to spermatozoal density of the sample presented on the day, but was significantly associated with those samples displaying less than 40% progressively motile forms regardless of whether the spermatozoal density was greater or less than 20 million per ml ($p < 0.001$). Nonetheless, it can be seen from TABLE 5 that pregnancies can be induced in all groups.

FIGURE 2 displays the fertilization rate for three infertile groups (unexplained, chronic oligospermic cases with oligospermic samples on the day of IVF, and the

TABLE 5. Relationship between Sperm Density and Percent of Motility of the Sample Used for Insemination in the Cases of Oocyte Recovery Resulting in Failed *in Vitro* Fertilization

Sperm Density (No. x 10^6/ml)	Number of Failed Fertilizations/No. of Cases (%) {No. pregnant}			
	Percent of Motility			
	<40%	40–60%	>60%	Total
<20	3/9 (33) {2}	1/6 {1}	0/4 {1}	4/19 (21) NS[a] {4}
≥20	8/27 (30) {2}	0/28 {2}	4/82 {10}	12/137 (9) {14}
Total	11/36 (31)[b] {4}	1/34 {3}	4/86 {11}	16/156 (10) {18}

[a]Not significantly different from group with ≥20 x 10^6 sperm/milliliter.
[b]Significantly different from groups with ≥40% motility ($p < 0.001$).

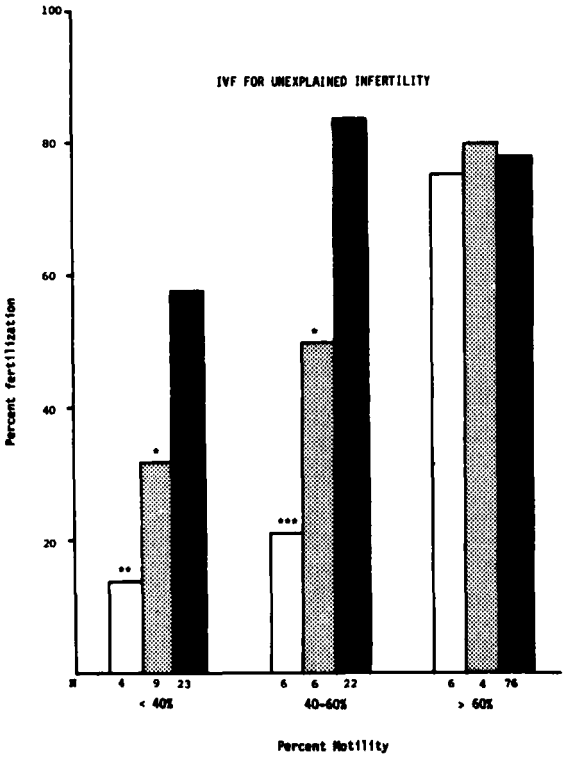

FIGURE 2. The fertilization rate of human ova *in vitro* for three groups of infertile patients as a function of the proportion of motile spermatozoa in the semen sample used for insemination. *Open bars:* cases of unexplained infertility; *light stipling:* cases of chronic oligospermia with oligospermic samples on the day of IVF; *dark stipling:* patients whose infertility is due to combined tubal/endometriosis factors and sperm antibodies.

combined tubal, endometriosis, and spermatozoal antibody groups). The data are analyzed separately as a function of the proportion of motile spermatozoa within the semen sample for fertilization. When the proportion of motile forms was >60%, no differences were noted in the three groups, but as the proportion of motile spermatozoa diminished, there was a significant reduction in fertilization rates for all cases when the motile proportion was <40% and for both the chronic oligospermic group and the group with unexplained infertility when the motile proportion was 60% or less.

DISCUSSION

Most units providing an IVF/ET service report fluctuations in the pregnancy rate between various work sessions. The pregnancy rate of 11.5% for laparoscopic oocyte recovery or 12.9% per embryo transfer is lower than the respective peak levels of 20.8% and 22.2% reported previously by us,[12] but is in keeping with the rate of 16.5% per embryo transfer reported by Edwards and Steptoe over the period from October 1980 to September 1982.[16] Although the pregnancy rate has fluctuated, the overall proportion of cases in whom oocytes were recovered and which proceeded to embryo transfer has constantly been greater than 85%.[12] Although we have recorded the number of pregnancies in each group throughout the series, it is relevant to appreciate that the fertilization rate of oocytes provides the most useful variable for analytical comparisons. For example, the absence of pregnancies in 14 cases of endometriosis (TABLE 1) is not considered significant since the fertilization rate of embryos in the sub-groups was similar to that of the tubal category. Pregnancies have previously been reported in earlier series within this program.[2]

In a previous report examining the fertilization rate and documenting pregnancies in patients where there is chronic oligospermia treated by IVF/ET, the reduced fertilization rate is found only in cases in which the semen exhibited 5 million motile spermatozoa or less per milliliter. Nonetheless pregnancy was achieved in two of ten such cases in that study. In this series we have examined the characteristics of all semen samples provided on the day of oocyte recovery within the series, including those in men with chronic oligospermia. Most reports concerning male infertility concentrate on spermatozoal density, but it is useful to note the findings in FIGURE 1 that show a reduced proportion of spermatozoa with progressive motility at the lower densities when compared with that of high-density semen. We have continued to show that while severely oligospermic males (≤5 million motile spermatozoa/ml) have a reduced potential for *in vitro* fertilization, there is no difference in results between moderate oligospermia (6 to <12 million motile spermatozoa/ml) and normospermia (≥12 million motile spermatozoa/ml) when the female factor is tubal or normal (TABLES 1 and 2).

As far as the *in vitro* fertilization of human oocytes is concerned, significant reductions in fertilization rates occur when: the semen sample presented on the day exhibits a progressively motile spermatozoal density of 5 million per milliliter or less in any sample (TABLE 2); less than 12 million motile spermatozoa are found in those who have a known history of chronic oligospermia, but not in cases previously known to be normal (TABLE 3); total spermatozoal density is <20 million per milliliter and the proportion of progressively motile forms is between 40–60%; or, for any density, the proportion of progressively motile forms is less than 40% (TABLE 4).

The picture that emerges from the study of semen samples throughout this series is that motility is the semen variable that relates most consistently to the fertilization potential of spermatozoa from any male. If there is a known history of chronic

oligospermia (based on the WHO definition), then semen samples from such males that contain <12 million motile spermatozoa per milliliter have a reduced fertilization potential, although this reduced potential is not apparent in samples of >5 million motile spermatozoa per milliliter if the total spermatozoal density is >20 million/ml. All semen samples from any males with less than 40% progressively motile forms are subfertile, and even those with up to 60% motility demonstrate reduced fertilization potential if the overall spermatozoal density is less than 20 million per milliliter.

It is clear that the clinical definition of oligospermia bears some relationship to the *in vitro* fertilization of mature human preovulatory oocytes. However, a number of qualifications revealed in the above data bear consideration in the final interpretation for any individual male or semen sample, depending on known history. Nonetheless, an absolute loss of fertilizing potential is not found in any of the aforementioned groups and pregnancies were produced in all categories. Given situations in which fertilization is likely to be reduced, we advise augmentation with human menopausal gonadotropin for the follicle stimulation regime, as we have previously shown that a mean of 4.8 large follicles can be obtained with hMG compared to 2.3 when clomiphene citrate is used alone.[12] In the evaluation of male infertility, a number of bioassays have been developed in recent years because of the uncertain correlation of semen analysis variables with fertility. A recent report compares the penetration of zona-free hamster eggs with the *in vitro* fertilization of human eggs by sperm from husbands participating in an IVF/ET program.[17] Although a highly significant correlation was obtained—the majority of eggs were fertilized in both groups—it is unlikely that the test will provide definitive value in the assessment of human infertility since the conditions for fertilization appear quite different in that at least 10 times the concentration of spermatozoa is required for hamster oocytes and their fertilization may more reflect the ability of spermatozoa to undergo the acrosome reaction[18] than correlate with motility, which appears to be the most important variable in our studies.

Interest is being focused on *in vitro* fertilization in cases of unexplained infertility. The data from this series (TABLE 1 and FIG. 2) confirm the finding of others that there is a reduction in the fertilization rate in such instances.[19,20] However, this is only apparent in our study when the proportion of motile spermatozoa is 60% or less. This finding is highly significant and reflects results similar to those where there is low spermatozoal density (TABLE 4), implying that although the density may well be normal in cases of unexplained infertility, the groups respond in a similar fashion, dependent upon spermatozoal motility. Again the effect is incomplete and pregnancies can certainly be achieved in the group with unexplained infertility. Similarly the analysis of those cases in whom there was failure of oocytes to fertilize at all revealed highly significant clustering in the groups displaying less than 40% progressively motile forms and was unrelated to spermatozoal density. By undertaking repeated attempts at *in vitro* fertilization and aiming to stimulate development of high numbers of oocytes, we would expect that a proportion of such cases would be fertilized. We have, in fact, achieved this on subsequent attempts although reduced spermatozoal motility is characteristically a persistent phenomenon and the proportion of cases in which embryos are formed under these circumstances remains low (unpublished observations).

In summary, we have confirmed that pregnancies can be achieved by *in vitro* fertilization where the male has oligospermia, even at levels between 1–5 million motile spermatozoa per milliliter. However, a number of semen variables that affect the rates of oocyte fertilization have been defined. Overall, the density of motile spermatozoa and the proportion of motile forms correlate most significantly with fertilization rates. There is a need to continue research in this area to determine the value of increasing

the number of spermatozoa available for fertilization and attempts to enhance spermatozoal motility, for example with caffeine, pH changes, or varying albumin concentrations. Ultrastructural studies of spermatozoa from men exhibiting low fertilization rates should also be undertaken since there may well be defects that are not apparent with light microscopy. However, semen with high proportions of morphologically abnormal spermatozoa (>60% atypical) exhibit normal *in vitro* fertilization rates,[4] possibly because the technique of semen preparation described here preferentially selects normal forms.

In vitro fertilization/embryo transfer should be regarded as a management option for oligospermic males and perhaps in cases of unexplained infertility, but the limitations within each group must be clearly considered since the pregnancy rates will be reduced as a reflection of the lower rate of oocyte fertilization. We suggest in such cases that consideration be given to cancellation of planned oocyte recovery if it is expected that only one or two mature preovulatory oocytes are available.

SUMMARY

The fertilization rates of mature preovulatory oocytes aspirated from 156 women treated by *in vitro* fertilization were analyzed as a function of spermatozoal density and motility and the findings were correlated with the category of infertility (chronic oligospermia, tubal disease, endometriosis, serum antibodies to spermatozoa in the female, and unexplained infertility). Overall reduced fertilization rates were found in all cases if the semen sample presented on the day of fertilization demonstrated ≤5 million motile spermatozoa per milliliter, <40% motile forms, or the combined findings of <20 million per ml and ≤60% motile forms. Where the husband was known to have chronic oligospermia, reduced fertilization was found if the semen on the day of fertilization contained <20 million spermatozoa per ml and <12 million motile spermatozoa per milliliter. For cases of unexplained infertility, a poor fertilization rate was noted if the semen demonstrated <60% progressively motile forms regardless of the overall spermatozoal density, implying that a proportion of unexplained infertility is due to a disorder of spermatozoa reflected by reduced motility. Pregnancies were achieved in 5 of 26 cases with chronic oligospermia, including 2 where oligospermia was very pronounced (≤5 million motile spermatozoa per milliliter).

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