

## Scientific Update: The relationship between sperm motility and morphology

The following table of reference studies provides evidence of the positive correlation between sperm motility and morphology:

Name of Publication	Text Summary	Publication Details
Reevaluation of the clinical importance of evaluating sperm morphology using strict criteria.	Table 1: Shows the positive correlation between the increase in % normal morphology and the increased content of motile sperm (page 2 of the article).	Check et al, Arch Androl. 2002 Jan-Feb;48(1):1-3.
Relation of the Morphological Alterations of Spermatozoa with Motility.	Morphological abnormalities of neck, midpiece and tail were significantly associated with impaired sperm motility.	Aydos et al, 2000 ARTEMIS (Journal of the Turkish-German Gynecological Association) Vol. 1 p. 5-8. <a href="http://www.artemisonline.net/volume/volume1/pdf/spermatozoa.pdf">http://www.artemisonline.net/volume/volume1/pdf/spermatozoa.pdf</a>
Seasonal changes in results of semen analysis from male members of an infertile married couple.	The increase of the percentage of pathologically abnormal forms correlates with decreased motility.	Swatowski et al, Ginekol Pol. 1994 Jan;65(1):29-34. p. 7.
Morphologic studies of spermatozoa in disorders of motility.	Quotation: "We have observed a highly significant correlation between morphological findings of mid-pieces and tails and the total motility as well as the progressive motility of spermatozoa".	Haidl et al, Andrologia 1987 Jul-Aug; 19(4):433-47.
Semen parameters in 114 fertile men.	Significant correlations were found between the number of spermatozoa/ml, percentage of motility, and normal forms.	Panidis et al, Eur J Obstet Gynecol Reprod Biol. 1984 Mar;16(6):411-20.
Lipid peroxidation in human spermatozoa as related to midpiece abnormalities and motility.	These results suggest that poor motility is linked with membrane fragility and that spermatozoa with midpiece abnormalities probably have membrane and/or cytoplasmic antiperoxidant system defects.	Rao et al, Gamete Res. 1989 Oct;24(2):127-34.

Name of Publication	Text Summary	Publication Details
Relationships between motility parameters, morphology and acrosomal status of human spermatozoa.	A high positive correlation was found between percentages of normal forms and progressive motility in the whole semen ( $r = 0.539$ , $P < 0.0001$ ) as well as in the Percoll fraction ( $r = 0.702$ , $P < 0.0001$ ).	Parinaud et al, Hum Reprod. 1996 Jun;11(6):1240-3.
Isolation of motile spermatozoa from semen samples using microfluidics.	The application of a sperm separation technique using a microfluidic device resulted in sperm motility increase from 44 +/- 4.5% to 98 +/- 0.4% ( $P < 0.05$ ) and morphology increase from 10 +/- 1.05% to 22 +/- 3.3% ( $P < 0.05$ ) following processing.	Schuster et al, Reprod Biomed Online. 2003 Jul-Aug;7(1):75-81.
Morphological and functional evaluation of spermatozoa from patients with asthenoteratozoospermia.	The findings in this study indicate that low motility of spermatozoa may be related to abnormal morphogenesis of the midpiece containing functional mitochondria.	Piasecka et al, Folia Morphol (Warsz). 2003 Nov;62(4):479-81.
Human sperm subpopulations: relationship between functional quality and protein tyrosine phosphorylation.	Using a discontinuous Percoll gradient, as expected, sperm isolated from the lowest density layer showed the poorest quality, displaying the smallest percentage of morphologically normal and motile sperm.	Buffone et al, Hum Reprod. 2004 Jan;19(1):139-46.

## Reference abstracts:

### **Arch Androl. 2002 Jan-Feb;48(1):1-3.**

Reevaluation of the clinical importance of evaluating sperm morphology using strict criteria.

Check ML, Bollendorf A, Check JH, Katsoff D.

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Several studies suggest that sperm with < or =4% normal morphology (NM) using strict criteria are sub fertile and IVF with ICSI may be needed. However, not all studies agree on the clinical importance of the use of NM with strict criteria. One study of males with oligozoospermia found a lower pregnancy rate (PR) following intercourse with sperm with NM > 14% compared to specimen with < or = 4%. The study presented herein evaluated the efficacy of intrauterine insemination (IUI) according to NM using strict criteria. The clinical PRs for first IUI cycles were 30% (28/91 ) for 0-4% normal forms, 26% (71/268) for range of 5-14%, and 20% (11/53) for >14%. This study corroborates previous data with intercourse only, suggesting that sperm with NM < or =4%, using strict criteria are not necessarily associated with lower fecundity.

\* In the text of Table1. Mean total motile sperm used for IUI according to strict criteria shows a positive correlation between % normal morphology and motility of sperm cells.

### **Ginekol Pol. 1994 Jan;65(1):29-34.**

Seasonal changes in results of semen analysis from male members of an infertile married couple.

Swatowski D, Robak-Cholubek D, Bakalczuk S, Jakiel G, Osinska-Stepien J, Przytula-Pilat M.

Kliniki Rozrodczosci z Andrologia Akademii Medycznej, Lublinie.

Analysis of 200 semen samples of men from childless couples was performed in order to evaluate the sperm characteristics during the year. Estimated were following features: semen volume, sperm density, motility and percentage of pathological forms. The sperm estimation data obtained from 4 seasons of the year was statistically evaluated. Statistically significant changes were found only in the percentage of pathological sperm forms. During the spring period the observed values were significantly higher than during summer and winter. From the correlation tables it appears that together with the increase of sperm density the percentage of pathological forms decreases. Whereas increase in density is correlated with the increase of sperm motility. **It was also revealed that together with the increase of the percentage of pathological forms the motility decreases.** Analogical results were obtained in all seasons of the year which indicates that there is a clear regularity existing. The least apparent dependencies were found in winter period.

PMID: 8070701 [PubMed - indexed for MEDLINE]

### **Andrologia. 1987 Jul-Aug;19(4):433-47.**

Morphologic studies of spermatozoa in disorders of motility

[Article in German]

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On the basis of microscopical examination and further differentiation by special stain techniques, a new classification of defects of midpieces and tails of spermatozoa will be presented: First degree disorders i.e. abnormalities of the staining behavior and minor structural defects, second degree disorders revealing breaks and coiling of spermatozoa tail, and finally severe third degree disorders

only exhibiting a rudimentary anlage of the terminal segment of spermatozoa. The staining abnormalities of the first degree disorders are characterized by nonreactivity to the Polychrome stain of the Papanicolaou technique as well as to scarlet red stain of the Shorr technique. Although the majority of these spermatozoa do not exhibit morphological aberrations, they have to be regarded completely immotile. Considering this classification, we have observed a highly significant correlation between morphological findings of midpieces and tails and the total motility as well as the progressive motility of spermatozoa.

PMID: 3662050 [PubMed - indexed for MEDLINE]

**Eur J Obstet Gynecol Reprod Biol. 1984 Mar;16(6):411-20.**

Semen parameters in 114 fertile men.

Panidis DK, Asseo PP, Papaloucas AC.

We studied the quality of semen in 114 fertile men (their wives were in the first trimester of pregnancy), aged 31.9 +/- 5.7 yr. The results (mean +/- S.D.) were as follows: number of spermatozoa, (72 +/- 61.6) X 10(6)/ml; motile spermatozoa, 56.6% +/- 13.5; spermatozoa velocity, 34.2 +/- 4.3 microns/s; motility index, 19.5 +/- 5.6 microns/s; normal forms, 51.7% +/- 13. It was found that the percentage of motile spermatozoa and the index of motility decrease progressively, at a rate of about 5-10% per hour. In contrast, in the majority of cases, sperm velocity increases during the first 4 h. Low significant correlations was found between percentage of motility and spermatozoa velocity the first hour after ejaculation. Furthermore, moderate significant correlations were found between number of spermatozoa/ml, percentage of motility and normal forms. Finally, low significant negative correlation was found between number of spermatozoa/ml and spermatozoa velocity.

PMID: 6734880 [PubMed - indexed for MEDLINE]

**Gamete Res. 1989 Oct;24(2):127-34.**

Lipid peroxidation in human spermatozoa as related to midpiece abnormalities and motility.

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The formation of malondialdehyde (MDA), a product of lipid peroxidation (LPO), was measured in human spermatozoa from 27 subjects with normal sperm characteristics. Peroxidation of lipids in washed spermatozoa was induced by catalytic amounts of ferrous ions and ascorbate and malondialdehyde determined by thiobarbituric method. MDA formation varied considerably from one sample to another. The studied population showed a strong correlation between lipid peroxidation potential (amount of MDA formed by 10(8) spermatozoa after 1 hour of incubation) and 1) initial motility  $r = -0.623$ ,  $P = 0.001$ ; and 2) morphologic abnormalities of the midpiece  $r = 0.405$ ,  $P = 0.05$ . These results suggest that poor motility is linked with membrane fragility and that spermatozoa with midpiece abnormalities probably have membrane and/or cytoplasmic antiperoxidant system defects. Because LPO potential is related to the two most important characteristics of fertility, it seems possible that it has the potential to become a good biochemical index of semen quality.

PMID: 2793053 [PubMed - indexed for MEDLINE]

**Hum Reprod. 1996 Jun;11(6):1240-3.**

Relationships between motility parameters, morphology and acrosomal status of human spermatozoa.

Parinaud J, Vieitez G, Moutaffian H, Richoille G, Milhet P.

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A total of 130 semen samples were examined for motility (by computer-assisted sperm analysis), morphology and acrosomal status. A high positive correlation was found between percentages of normal forms and progressive motility in the whole semen ( $r = 0.539$ ,  $P < 0.0001$ ) as well as in the Percoll fraction ( $r = 0.702$ ,  $P < 0.0001$ ). Among the specific abnormalities, acrosome defects were most highly correlated with progressive motility ( $r = -0.492$ ,  $P < 0.0001$ , in the Percoll fraction). The percentage of total spontaneously acrosome-reacted spermatozoa in the Percoll fraction was negatively correlated with the progressive motility ( $r = -0.499$ ,  $P < 0.0001$ ) and with the percentage of normal forms ( $r = 0.430$ ,  $P < 0.0001$ ). Surprisingly, the percentage of total spontaneously acrosome-reacted spermatozoa was poorly linked with head abnormalities but displayed significant positive correlations with the percentages of bent tails ( $r = 0.359$ ,  $P < 0.0001$ ) and of coiled tails ( $r = 0.371$ ,  $P < 0.0001$ ). These data suggest that sperm defects are often linked together, reflecting spermiogenesis and/or epididymal dysfunctions.

PMID: 8671432 [PubMed - indexed for MEDLINE]

**Reprod Biomed Online. 2003 Jul-Aug;7(1):75-81.**

Isolation of motile spermatozoa from semen samples using microfluidics.

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A microfluidic device was designed with two parallel laminar flow channels where non-motile spermatozoa and debris would flow along their initial streamlines and exit one outlet, whereas motile spermatozoa had an opportunity to swim into a parallel stream and exit a separate outlet. Motile sperm samples were prepared with density gradient separation ( $n = 5$ ). Sperm motility was assessed the following day after exposing aliquots to polydimethylsiloxane (PDMS) used to construct the device. There was no difference in sperm motility when compared with unexposed aliquots ( $P > 0.05$ ). Unprocessed semen samples ( $n = 10$ ) were placed in wider channels and sperm motility and strict morphology were assessed from sorted outlets. Sperm motility increased from  $44 \pm 4.5\%$  to  $98 \pm 0.4\%$  ( $P < 0.05$ ) and morphology increased from  $10 \pm 1.05\%$  to  $22 \pm 3.3\%$  ( $P < 0.05$ ) following processing. Finally, density gradient prepared samples ( $n = 6$ ) containing  $5 \times 10^6$  motile spermatozoa/ml and  $50 \times 10^6$  round immature germ cells/ml were sorted and assessed in a similar fashion. The ratio of motile spermatozoa to round immature germ cells in the wide inlet (1:10) was significantly improved in the thin outlet (33:1) ( $P < 0.05$ ). This microfluidic device provides a novel method for isolating motile, morphologically normal spermatozoa from semen samples without centrifugation. This technology may prove useful in isolating motile spermatozoa from oligozoospermic samples, even with high amounts of non-motile gamete and/or non-gamete cell contamination. A movie sequence showing streaming and sorting of spermatozoa may be purchased for viewing on the internet at [www.rbmonline.com/Article/847](http://www.rbmonline.com/Article/847) (free to web subscribers).

PMID: 12930579 [PubMed - indexed for MEDLINE]

**Folia Morphol (Warsz). 2003 Nov;62(4):479-81.**

Morphological and functional evaluation of spermatozoa from patients with asthenoteratozoospermia.

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In several cases of asthenoteratozoospermia, electron microscopic investigation displayed immature sperm forms, morphological apoptotic patterns of spermatozoa and many cytoplasmic conglomerates with fragments of the sperm. In these patients, TUNEL assay showed a high percentage of spermatozoa with nuclear DNA fragmentation. Moreover, thickened and deformed midpieces were observed which contained supernumerary and redundant mitochondria with normal oxidoreductive capability and normal membrane potential. In these cases a high percentage of spermatozoa with normal DeltaPsim was detected. Nevertheless, a subpopulation of patients was found with an abnormal ultrastructure of sperm mitochondria and with a low percentage of spermatozoa with normal DeltaPsim. **These findings indicate that low motility of spermatozoa may be related to abnormal morphogenesis of the midpiece containing functional mitochondria** and that this may be a possible consequence of an apoptotic mechanism. Furthermore, our results show that asthenoteratozoospermia may result from dysfunction of sperm mitochondria and/or with alternations of the structures involved in sperm motility, i.e. the dense outer fibres, the fibrous sheath and the axoneme.

PMID: 14655146 [PubMed - indexed for MEDLINE]

**Hum Reprod. 2004 Jan;19(1):139-46.**

Human sperm subpopulations: relationship between functional quality and protein tyrosine phosphorylation.

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BACKGROUND: Human semen is composed of a heterogeneous population of sperm with varying degrees of structural and functional differentiation and normality, which result in subpopulations of different quality. METHODS: Using a discontinuous Percoll gradient, we separated three subsets of sperm [(45%; L45), (65%; L65) and (90%; L90) fractions] from normozoospermic human semen samples from healthy donors and proceeded to characterize their morphology, motility and hyperactivation, as well as their ability to undergo tyrosine phosphorylation under capacitating conditions. RESULTS: **As expected, sperm isolated from the lowest density layer (L45) showed the poorest quality, displaying the smallest percentage of morphologically normal and motile sperm.** During a capacitating incubation, this subset of cells also showed deficient capacity to undergo hyperactivation and protein tyrosine phosphorylation. Conversely, sperm isolated from the other layers (L65 and L90) showed a time-dependent progressive increment in tyrosine phosphorylation, establishing statistically significant differences with sperm from L45. The tyrosine phosphorylation deficiency of L45 sperm could be overcome when sperm from that fraction were stimulated with activators of the cAMP-dependent kinase (PKA) pathway (dbcAMP + pentoxifylline), pointing to the sperm's plasma membrane as the main site of such deficiency. CONCLUSIONS: Poor quality sperm isolated from a Percoll gradient display an intrinsic tyrosine phosphorylation deficiency, possibly caused by a plasma membrane defect, which is associated with their inability to undergo normal capacitation and, ultimately, acquire optimal fertilizing potential.

PMID: 14688172 [PubMed - indexed for MEDLINE]