The Impact of Sedentary Occupation and Long Distance Travel on Semen Quality

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Summary: Precise thermoregulation within the testis is very essential for normal development and maturation of spermatozoa. Since sperms are produced at a temperature lower than the normal body temperature (37°C), even slight elevations in testicular temperature may have a profound impact on sperm quantity, quality, and fertilizing potential. This study was designed to evaluate the influence of prolonged seating in long distance traveller and sedentary workers on semen quality. Observations revealed a significant impairment in spermatogenesis, percentage sperm motility, and normal morphology in particular head morphology in both the groups studied. Sedentary workers spent longer hours seated than long distance traveller (7.9 hours/day Vs 4.25 hours/day). The comparatively more significant deterioration in semen quality in sedentary workers than long distance traveller compared to controls supports the profound negative impact of heat stress on the sperm parameters assessed. The increased testicular temperatures, a result of prolonged seating may be a factor directly responsible for the deterioration of semen quality and consequently infertility in this category of patients. The contribution of scrotal heating in the deterioration of semen quality may further be supported by the fact that whereas vehicular pollution may confound the adverse effects on sperm in long distance travelers, effects observed in sedentary workers could be attributed only to increased testicular temperatures, environmental exposure being negligible.

Introduction

Sperms are normally produced at a temperature lower than the normal body temperature 37°C. The testis is more vulnerable to heat than any other organ of the body (Bonde et al, 1996) and the importance of precise thermoregulation of the testis is evidenced by the fact even slight elevations in scrotal temperature are associated with infertility. The lower temperature in the testes located in the scrotum is crucial for normal sperm development and maturation. Studies in men include observation of suppressed spermatogenesis in clinical conditions associated with increased testicular temperature such as cryptorchidism, retractile testes, varicocoele, and acute febrile illness. An artificially induced increase in scrotal temperature by the application of polyester scrotal slings that bring the testes closer to the abdomen, has been shown to induce oligospermia and a corresponding decrease in motility (Moelock et al, 1995), and azoospermia within 4 to 5.5 months which could be maintained upto 12 months with continued use (Shafik et al, 1992). The initiation of translation in pachytene spermatocytes and Sertoli cells is inhibited by exposure of mice testes to abdominal temperatures of 37°C, thus severely inhibiting spermatogenesis (Cataldo et al, 1997).

Long distance sedentary travelers, travelling for more than 200 km more than 3 hours/day, and sedentary workers spending more than 6 hours/day seated at work, by virtue of prolonged seating that results in increased scrotal temperature, could be victim to similar consequences. Long hours of sedentary work or travel may be a risk factor for semen quality (Figa Talamanca et al, 1996). Though there have been studies reporting the effect of an artificially induced heat stress on the testis in animals, studies in men occupationally at risk due to the long distances travelled for work or long hours spent at work are limited. The aim of the study was to evaluate semen quality in long distance travelers and sedentary workers with no associated clinical pathology and to probe into the latent causes that often lead to the diagnosis of "unexplained infertility".

Material and Methods

A detailed history of couples attending the Assisted Conception Services Unit, Mahavir Hospital and Research

Centre, was taken and those couples presenting with a male factor problem but a normal female profile were included in the study. Normospermic men with no evidence of male factor infertility, a non-sedentary occupation and time lesser than 1 hour in travel were taken as controls. The criteria for the inclusion of patients in the study were i) No history or evidence of varicocoele, retractile testes, or cryptorchidism, ii) no history of febrile illness in the six months prior to analysis, iii) no evidence of semen infection (ruled out by semen culture and sensitivity), iv) no history of smoking or tobacco consumption, v) no history of occupational exposure to toxic substances. All men underwent a thorough clinical evaluation by a urologist to rule out any associated clinical pathology. The semen samples of 45 men were analyzed after a proscribed three day period of abstinence, for sperm count, motility, morphology, vitality, hypo-osmotic swelling test (HOS), and the presence of immature germ cells as a part of the investigation into their infertility. Vitality was assessed by Eosin-Nigrosin staining, morphology and the presence of immature germ cells by Papanicolaou staining. The HOS test score was obtained by substracting the percentage of sperm with swollen tails following treatment with the hypo-osmotic solution (osmotically competent spermatozoa). The men were categorised into three groups depending on the nature of occupation, the mode of travel, the distance and time spent in travel. The three groups were as follows: Group A- Controls; Group B- long distance travelers who spent more than 3 hours/day in travel; Groupp C- Sedentary workers who spent more than 6 hours/day seated at work.

Results

It was observed that semen quality was significantly impaired with respect to sperm count, motility, percentage normal morphology, the presence of immature germ cells, and vitality in long distance traveller when compared to controls. Rapid linear progressive motility was significantly decreased ($p<0.4$), slow linear progressive and non-progressive motility was significantly higher ($p<0.4$) in group B than controls. The percentage normal morphology was significantly decreased and abnormal morphology increased ($p<0.4$), head defects and mid-piece defects being significantly higher ($p<0.1$ and $p<0.5$ respectively) in group B. Immature germ cells showed a significant increase, and vitality a significant decrease ($p<0.4$) in group B when compared to controls. Long distance travelers demonstrated a decline in sperm count and HOS test scores, and an increase in non-motile sperm when compared to controls, but the difference was however insignificant. Sedentary workers likewise demonstrated a highly significant impairment in almost all aspects of semen quality i.e sperm count, motility, and percentage normal morphology and comparatively worse prognosis than long distance travelers in comparison to controls. There was a highly significant decrease in sperm count, and percentage normal morphology ($p<0.025$ and $p<0.005$ respectively), and a corresponding significant increase in abnormal morphology ($p<0.005$), in particular head defects ($p<0.05$). Motility was significant impaired slow linear progressive, non-progressive motility, and non motile sperm being higher ($p<0.1$, $p<0.2$, and $p<0.4$ respectively) in group C when compared to control. Immature germ cells in the semen of sedentary worker were significantly higher ($p<0.5$) when compared to controls. Rapid linear progressive motility, and HOS test scores were decreased in group C when compared to controls, but the difference was however insignificant. The results of the various semen parameters assessed in the three groups of patients are given in Table 1.

Discussion

Sedentary workers considered in this study, were reported to have spent a mean of 7.9 hours/day seated compared to long distance traveller who spent a mean of 4.25 hours/day seated. It is clearly evident from the results that increased hours spent seated as is the case in long distance traveller (group B) and sedentary workers 9group C) deteriorates semen quality, the increase in time having direct bearing on the extent of damage. This is exemplified by the highly significant decrease in sperm count in group C ($p<0.025$), but an insignificant decrease in group B in comparison to controls.

With regard to motility, sedentary workers demonstrated significantly higher numbers of non motile sperm ($p<0.4$), in comparison to the insignificant increase in long distance travelers. This, and the higher incidence of slow linear progressive and non-progressive motility in group C than B ($p<0.1$ Vs $p<0.4$, and $p<0.2$ Vs $p<0.4$ respectively) when compared to controls is supportive of the facts that the increase in time spent seated results in the degradation in sperm motility. The progressive decrease in levels of significance of slow linear progressive, non progressive,

Table-1

Semen Qualiity in Long Distance Travellers and Sedentary Workers

Characteristics	Controls	Long distance travellers	Sedentary workers
Number of patients	15	15	15
Mean hours seated/ day	0.5	4.25	7.9
Sperm count (mill/ml)	80.75±11.07	66.23±103.86	47.9±10.82*
Rapid linear progressive motility(%)	52.0 ± 9.2	39.75±15.78#	46.8±9.23
Slow linear progressive motility(%)	12.33±3.14	26 ± 14.4 $	17.43±1.99*
Non-progressive motility (%)	18.8±2.05	6.25±1.5 *	8.67±2.74*
Non-motile (%)	18.83±5.19	25.5±18.36	25.5±7.42*
Normal morphology (%)	57.25±3.95	39.75 ± 22.08*	38.67±5.05*
Abnormal morphology (%)	42.75±3.95	65.6 ± 22.56*	61.25±4.33*
Head defects (%)	18±4.55	31.67±8.96•	0.21±10.37*
Mid-piece defects (%)	14.75±5.9	21±9 u	3.67±3.08
Tail defects (%)	11.43 ± 0.56	2.37± 3.61p	0.95±0.8*
Vitality (%)	83.13 ± 7.02	65.5±24.58v	87.6±7.72
Hypo-osmotic swelling test (%)	56± 12.56	54.29± 19.04	50.5±2.79

Values represent mean ± sd

#p <0.4; $ p <0.4; * p<0.4; * p <0.4; * p <0.4, • p <0.1; u p <0.5; p p <0.4; v p <0.4

*p <0.025; * p< 0.1; * p < 0.2; * p <0.4; * p <0.005; * p <0.005; r p <0.05; * p<0.5

and non-motile sperm (p<0.1, p<0.2, p<0.4 respectively within sedentary workers is further suggestive of the gradual deterioration in sperm motility to the point of immobilization following heat stress.

The percentage normal morphology was once again more significantly impaired in group C than B (p<0.005 Vs p<0.4), compared to controls, head morphology being the most affected (p<0.05 Vs p<0.1). The higher percentage of abnormal head morphology in long distance travellers and sedentary workers could be attributed to a possible denaturation of proteins that specify head shape and size. Recent studies have indicated vitality as assessed by Eosin-Nigrosin staining and hypo-osmotic swelling test as a marker of the acrosomal status and hence sperm functional capacity (Gopalkrishnan and Padval, 1997). The HOS test was originally described as test of sperm function with a good correlation with the zona-free hamster egg penetration test. The morphological changes induced in the spermatozoon, in particular tail swelling, following hypo-osmotic stress are thought to indicate membrane integrity and normal functional activity of the spermatozoon (Jeyendran et al, 1984). Whereas the HOS test assesses the osmoregulatory capacity of spermatozoa, and makes a distinction between the membrane functional integrity of live, and senescent and dead sperm, Eosin-Nigrosin staining gives a clue to the physiological status or cytological intactness of the cell, making an ultimate distinction between live and dead sperm. It is unclear how cytological stains affect DNA integrity, and moreover, vitality as assessed by Eosin-Nigrosin cannot make a distinction between senescent sperm which may be physiologically live and yet have poor osmoregulatory capacity, and viable sperm with good osmoregulatory capacity. The decrease in HOS test scores in both groups B and C, when compared to group A though insignificant indirectly suggests that in addition to sperm motility and morphology, sperm fertilizing potential may also be impaired, a parameter that is perhaps a more important aspect of fertility than sperm count per se. The low percentage of tail defects in sedentary workers is evidence of the fact that the low HOS scores in this group reflect an overall poor membrane functional integrity, rather than which can be attributed to a high percentage of coiled tails, among the most common tail defects, as seen in long distance travelers. Hence, the decreased HOS scores

in sedentary workers are probably more significant than the unexpectedly high percentage sperm vitality observed when compared to controls.

Immature germ cells in semen were significantly higher in group B than C ($p<0.4$ Vs $p<0.5$) when compared to controls, an indication of incomplete spermatogenesis. The testicular germ cell loss observed with exposure to heat stress might be attributed to apoptosis. Heat stress induces the translocation of p53 into the nucleus where it may act as DNA binding protein to induce apoptosis or cell cycle arrest (Yin et al, 1997).

It must be emphasized here that long distance travellers may experience prolonged exposure to vehicular pollution during travel in addition to increased testicular temperatures whereas sedentary workers largely experience only the latter due to the nature of their occupation and comparatively shorter distances traveled. Hence, whereas the deleterious effects on sperm parameters in long distance travellers could be attributed to prolonged heating, vehicular pollution or both, the effects observed in sedentary workers could only be attributed to heat stress, which is further supportive the adverse effects of higher testicular temperatures on sperm quantity, quality and fertilizing potential. Sedentary workers particularly at risk included drivers, managers, computer operators, shop proprietors, and bank officers.

Long distance travellers additionally suffered a significant decrease in rapid linear progressive motility, sperm vitality, and mid-piece defects ($p<0.4$, $p<0.4$, $p<0.5$ respectively) compared to controls which could possibly be attributed to vehicular pollution. The time spent in travel has more profound impact on semen quality rather than the distance or mode of travel.

Earlier studies have reported no significant changes in sperm quantity, quality, and fertilizing capacity with an increase in temperature from 0.8° C to 1° C (Kandeel and Swerdloff, 1988). From the results obtained in this study, it may be deduced that in long distance travellers and sedentary workers, prolonged seating for more than 3 hours/ day may result in testicular temperatures that exceed by greater than 1°C above baseline as demonstrated in testes retained within the inguinal canal by experimental cryptorchidism (Mieusset et al, 1985) or other means. The increased testicular temperatures could possibly contribute to the poor semen quality and the infertility. Since continuous seating is a routine in these groups of patients, the defect remains. The very fact that the reversible effect of an artificially induced heat stress is being explored as an agent for male contraception (Wang et al, 1997), emphasizes the significance of elevated testicular temperature in the deterioration of semen quality.

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