

Effects of Aluminium Chloride on Human Spermatozoa

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Aluminium (Al), which is the most prevalent metal in the earth's crust, has been implicated as an etiological factor in a variety of clinical disorders (Berman, 1980; Wills and Savory, 1983; Alfrey et al., 1985; Ganrot, 1986). Only recently Al has been discussed in the pathogenesis of the parenteral nutrition - associated liver disease (Klein et al., 1982, 1984). Included in this report are the preliminary findings on its effects on the reproductive functions of human beings.

MATERIALS AND METHODS

Human semen was obtained from healthy donors, by masturbation, and used after liquefaction; all semen samples had a sperm concentration of 80×10^6 spermatozoa/ml and 67% motility. Bovine estrous cervical mucus was used in this study (either fresh or stored at -20°C for not less than 3 weeks), because the sperm penetration characteristics are comparable with human mid-cycle mucus (Gaddum-Rosse et al., 1980). The mucus was aspirated directly from the cervixes of cows and kept at -20°C into a sterile container. For observing the effects of aluminium chloride on the penetrability ability of sperm into the mucus, the mucus was first introduced by gentle suction, into a rectangular glass capillary tube ($50 \times 1.0 \times 0.2$ mm), taking care to avoid the formation of air bubbles in the column of mucus. One end of the capillary tube was immediately sealed to prevent evaporation; the other end was placed in contact with the various concentrations of aluminium chloride (AlCl_3 ; 10, 100, 200 μM) in normal saline. For control experiments, only normal saline was used. The duration of exposure varied between 10 and 60 minutes). After this period, the opposite, sealed end of the tube was opened and a reservoir of semen applied; sperm penetration was allowed to proceed for an additional 2 hours (contact with the

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reservoir of test substance was maintained during this period). The extent of sperm penetration was measured by counting the total number of sperm in sequential visual fields ($\times 100$ total magnification using phase contrast optics) and noting the proportion of immotile sperm. All tests were performed at 25°C in triplicate. The results were analyzed by comparing equivalent visual fields along the capillaries containing control or test cervical mucus. The comparison was scored as positive if the test result exceeded the control result, zero if the test result was equal to the control result, and negative if the control result exceeded the test result. If the test and control results were equivalent, the numbers of positive and negative comparisons would be equal. This hypothesis was examined with the sign test (Hollander and Wolf, 1973), which is based on binomial distribution. All statistical tests performed were two-sided.

RESULTS AND DISCUSSION

When aluminium chloride 10 to 200 $\mu\text{M}/\text{ml}$ was used, there was a highly significant ($P < 0.001$) inhibition of sperm entry into the mucus at all concentrations (Table 1). The

Table 1. Sperm penetration of mucus containing aluminium chloride^a

Contact time (min.)	Score	Incidence of scores at different concentrations of aluminium chloride		
		10 $\mu\text{M}/\text{ml}$	100 $\mu\text{M}/\text{ml}$	200 $\mu\text{M}/\text{ml}$
0	+	0	0	0
	-	13s	11s	14s
	0	18	16	19
10	+	0	0	0
	-	12s	11s	14s
	0	17	16	19
30	+	0	0	0
	-	13s	12s	13s
	0	18	17	18
60	+	0	0	0
	-	14s	11s	14s
	0	19	16	19

^aThe mucus was in surface contact with either normal saline or 10-200 $\mu\text{M}/\text{ml}$ aluminium chloride. After 2 hours penetration, adjacent fields were sampled and scored +, -, or 0 (see text for explanation).

^ssignificant at $P < 0.001$; the significance refers to each block of 3, i.e., +, -, 0.

sperm penetrated upto one half or usually less than one third of the distance achieved in the control mucus. In the preovulatory period, the cervical mucus is at its greatest volume, and it is receptive to the entry and transport of sperm (Moghissi 1966) and increasing numbers of sperm move into the cervical mucus as also observed in the control experiments in this investigation. The presence of aluminium chloride in the cervical mucus in various concentration gradients may structurally alter the cervical mucus, preventing the upward move of spermatozoa or it might have affected the motility machinery of spermatozoa directly. In either way aluminium does seem to have adverse effects on the human sperm performance.

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