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Abstracts

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ALTERATIONS IN INTRACELLULAR CALCIUM DURING BEDREST WITH AND WITHOUT EXERCISE

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We applied a new technique to determine the effect of immobilization with and without exercise on the intracellular concentration of calcium. Homogenous cell smears were fixed on low background slides and identified by electron microscopy. The intracellular ion content of calcium (ICCa) was quantitated by the spectra generated from energy dispersive X-Rays, and expressed as X-Rray intensity, peak/background per unit cell volume ($800\mu^3$) or EXA units (IntraCellular). Sublingual cells were selected because they are non-cornified, aerobic, protected from trauma, rapidly growing, and need minimal preparation. We studied 19 normal men who participated in a 30 day –6 degree head down bed rest study to compare the effect of two forms of exercise and no exercise on vascular and muscular deconditioning. Subjects exercised for 30 minutes twice daily with either an Ergometer-isotonic (E) or a Lid-isokinetic (L). Calcium concentrations (+/- SD) in cells and blood (Sca) obtained before and on the 28th day of bed rest showed increased ionized calcium in all 3 groups; and increases in ICCa only in the control group (C).

		Ambulatory		Bedrest	
	n	EXA units	Sca mg/dl	EXA units	SCa mg/dl
C	5	81 + /-14	4.49 + /-.11	109 + /-15*	4.95 + /-.14**
E	7	69 + /-11	4.66 + /-.36	92 + /-32	4.98 + /-.10
L	7	77 + /-16	4.58 + /-.26	69 + /-11	4.88 + /-.14

*** = p<.05 ** = P.01**

This data suggests that the ICCa sublingual epithelium provides a sensitive measure of the shifts in calcium distribution during bedrest. Both isokinetic and isotonic forms of exercise prevent the influx of calcium into the cell without an apparent effect on circulating calcium levels. The metabolic changes underlying the increase in intracellular calcium during bedrest require additional investigation.

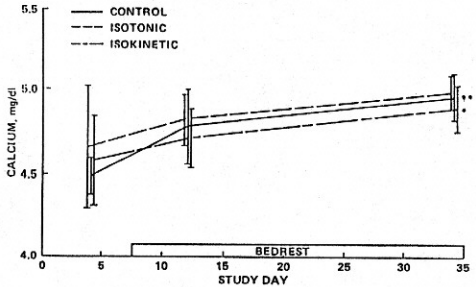
SIMPLE REGRESSION ANALYSIS OF THE CHANGE IN INTRACELLULAR CALCIUM CONCENTRATION vs. THE CHANGE IN THE FOLLOWING PARAMETERS:

	r
INTRACELLULAR	
P	0.617**
Mg+	0.187
Na+	0.597**
K+	0.478*
Cl-	0.003
SERUM	
TCa	0.484**
Ca+	0.015
P	0.258
Ph	0.137
HORMONES	
CORTISOL	0.260
1,25 VIT D	0.501*
PTH	0.266
BONE	
L2-4	0.026
RADIUS	0.197
OTHER	
OSTEOCALCIN	0.137
C-AMP	0.343
PLASMA VOLUME	0.239
BSA	0.197
VO2	0.062
BW	0.190

* = P < .05

** = P < .01

CHANGES IN SERUM IONIZED CALCIUM DURING 30 days -6° HEAD DOWN BEDREST



SERUM IONIZED CALCIUM

(mg/dL)

STUDY DAY

GROUP	N	DAY 4	DAY 12	DAY 34
NO EXERCISE	5	4.49 ± 0.11	4.78 ± 0.22	4.95 ± 0.14**
ISOTONIC	7	4.66 ± 0.36	4.82 ± 0.15	4.98 ± 0.10
ISOKINETIC	7	4.58 ± 0.26	4.71 ± 0.17	4.88 ± 0.14*

COMPARED TO PRE-BEDREST

*p < 0.05

**p < 0.01

COMPARED TO NO EXERCISE

†p < 0.05

††p < 0.01

MEAN DATA

CALCIUM HOMEOSTASIS DURING 30 days -6° HEAD DOWN BEDREST STUDY

	DAY 4	DAY 12	DAY 34
TOTAL SERUM CALCIUM, mg/dl	9.35 ± .39	9.21 ± .32	9.41 ± .36
TOTAL PROTEIN, mg/dl	6.7 ± .74	6.6 ± .70	6.9 ± .54
IONIZED SERUM CALCIUM, mg/dl	4.58 ± .27	4.77 ± .17	4.93 ± .13*
VENOUS pH, units	7.47 ± .04	7.46 ± .05	7.44 ± .06
SERUM PHOSPHORUS, mg/dl	2.8 ± .37	2.9 ± .43	2.9 ± .47
PARATHYROID HORMONE, pg/ml †	28 ± 9	24 ± 11	24 ± 11
1,25 DIHYDROXY VITAMIN D, pg/ml	46 ± 15	37 ± 15	36 ± 10

* p < .01

(5 SUBJECTS IN THE NO EXERCISE GROUP AND 7 IN EACH EXERCISE GROUP)

† ASSAY OF R. MARCUS, VA HOSP. PALO ALTO, CA.

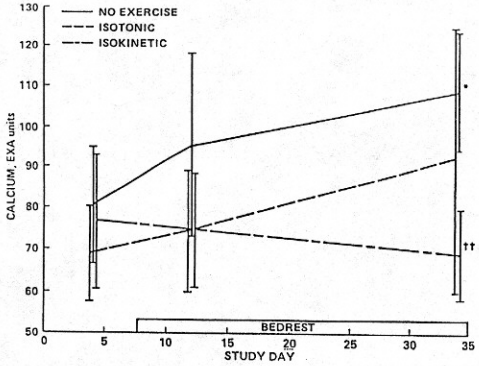
MEAN DATA DURING 30 days -6°
HEAD DOWN BEDREST STUDY

INTRACELLULAR MINERALS AND ELECTROLYTES

	EKA units ± SD		
	DAY 4	DAY 12	DAY 34
CA+	75 ± 14	80 ± 18	87 ± 26*
Mg+	776 ± 29	781 ± 29	796 ± 28
K+	94 ± 25	108 ± 52	135 ± 57*
Na+	13 ± 2	14 ± 1	14 ± 2
Cl-	26 ± 5	29 ± 6	24 ± 5
P	1149 ± 79	1169 ± 95	1296 ± 222*

* p < .01

EFFECTS OF EXERCISE AND NO EXERCISE ON INTRACELLULAR CALCIUM DURING 30 days -6° HEAD DOWN BEDREST

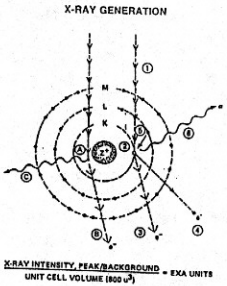


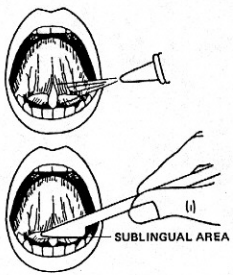
INTRACELLULAR CALCIUM
(EXA UNITS)

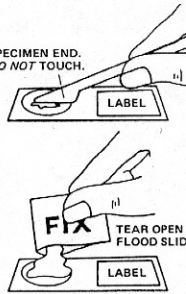
GROUP	N	STUDY DAY 4	STUDY DAY 12	STUDY DAY 34
NO EXERCISE	5	80.8 ± 14.2	95.6 ± 22.4	108.6 ± 14.6*
ISOTONIC	7	69.0 ± 11.3	74.6 ± 14.6	92.1 ± 32.2
ISOKINETIC	7	76.9 ± 16.1	74.9 ± 13.7	68.9 ± 10.7††

COMPARED TO PRE-BEDREST
*$p < 0.05$
**$p < 0.01$

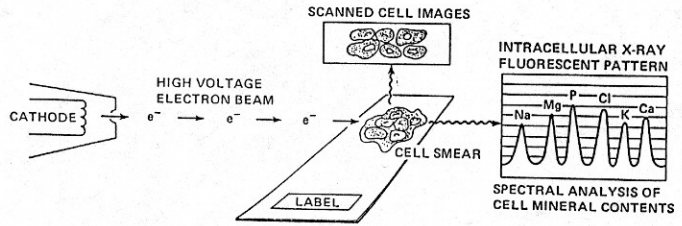
COMPARED TO NO EXERCISE
†$p < 0.05$
††$p < 0.01$







INTRACELLULAR ANALYSIS



(pat pending Spectro-Scan Inc.)