A NEW HUMAN WALK SIMULATOR: DEVELOPMENT AND "IN VITRO" VALIDATION

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INTRODUCTION

With the aim, to create a walking simulator able to reproduce bone stimulation in a stable and constant environment, we compare data obtained by a coupled accelerometer sensor located inside cell culture plate and human walk. Them we use the obtained data to stimulate the walking stimulation in cultured human osteoblast cells.

In general, bone cell stimulation is getting through applying an electromechanically device some mechanical stimuli directly to cells. These stimuli correspond in our prototype system to the mathematical wave form of natural walk that are applying in human osteoblastic cells attached in a synthetic matrix that mimic bone structure. In this way, we try to compare between results obtained using wave form stimulation and without stimuli. Finally we develop a human scale prototype for clinical studies.

METHODS

Walking data:

In order to obtain a standard walking patter, we have used 6 different people monitories during their normal movement like, walk, run, jump and tiptoe in separated sequences of 30 seconds approximately. We have selected the people with as different physical profiles as possible (talls and small, heavy), 3 man and 3 women, with the intention to know how these parameters affect the walking profile. The legs movement monitoring has been done using a specific sensor located in the right leg by the ankle, in the inner part of the leg. The sensor is able to detect small accelerations in X (vertical) and Y (horizontal) axes. In this case, the analyze will be focused in the X axe data (axe distribution: positive down) due to the interest to obtain a pattern that could be produced in an vertical stimulation machine (from bottom to top). It has been possible obtain walking patterns for the different subjects in spite of their different physical conditions and different walking characteristics.

"In vitro" stimulation:

The culture plate is formed by many holes were osteoblastic cells are attached to the synthetic matrix, even the matrix is elastically attached to the hole. The inner part of the culture plate contain the culture medium needed for cell grow. We evaluate APL (Alkaline Phosphatase) activity, DNA quantity and the synthetic matrix affection.

Prototype design:

With the data obtained we have developed a mechanical platform able to reproduce the same wave form and accelerations that human walk.

RESULTS AND DISCUSSION

We have check, wave forms for each kind of movement (walk, jump, run and tiptoe) they are similar and the main differences are in the suffered impact magnitude. In this way, some small differences between men and women have been observed when they jump or tiptoe but not walking or running

The stimulation of cells with walking patterns increases in an impressive way the cellular activity, not only the number of bone-like cells also the alkaline phosphatase activity in comparison with non stimulated cells (control). Also we appreciated changes in the re-absorption ratio of synthetic matrix.

AP Activity (pg)

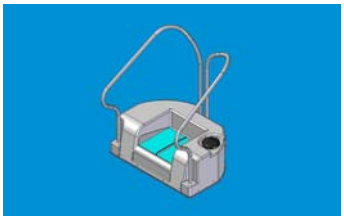
Time (days)	Media	SD
* Day 0	11.838	3.990
Sti/4d	12.544	1.461
Non Sti/4d	4056	1135
Sti/7d	5028	1850
Non Sti/7d	4591	1425

DNA/Cells

Time (days)	DNAng/ml	SD	Cell number	SD
* Day 0	6,27	3,36	20.230,83	16.794
Sti/4d	8,79	1,39	33.665,55	4.874
Non Sti/4d	3,49	3,01	9.579,51	11.303
Sti/7d	9,89	0,93	38.294,60	4.963
Non Sti/7d	3,50	1,48	7.285,13	6.025

** The 0 day data are corresponding to the total number of cells seeded, only a 10% of seeded cells attach to the 3D matrix, due to this reason the initial number of cells used is higher. The decrease of AP activity at 7 days is usual in differentiated osteoblastic cells due to pass to mineralization stage.*

Applying the data and experience obtained in the "in vitro" simulation we have developed a mechanical platform able to support human height and transmit the same stimuli tested "in vitro".



CONCLUSIONS

We observe impact magnitude differences inside heel and fingertips between people heavy and light when they are running but not in a common way for all the people. The stimulation of cells with walking patterns increase in a impressive way the cellular activity, not only the number of bone-like cells also the alkaline phosphatase activity in comparison with non stimulated cells (control).Also we have appreciated changes in the re-adsorption ration of synthetic matrix. The prototype platform may be a useful tool for clinical studies.

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