1. What is the mechanical regulation of cell differentiation during bone regeneration?

The mechanical regulation of cell differentiation is based on the model created by Prendergast et al. 1. The model proposes that a combination of shear strain () and fluid velocity (v) results in a mechanical stimulus, S, that directs which type of cells, mesenchymal stem cells, differentiate during bone regeneration. The model follows the equation:

A mathematical equation with black letters

AI-generated content may be incorrect.

where a = 0.0375, b = 3 µm/s

* High mechanical stimulus (S>3): mesenchymal stem cells differentiate in fibroblasts
* Medium mechanical stimulus (1<S<3): supports chondrogenic differentiation
* Low mechanical stimulus (S<1): stimulate MSCs differentiation into osteoblasts.

1. What mechanical (poroelastic) characteristics of tissue enter the main parameter of mechano-regulation?

Octahedral shear strain and fluid/solid velocity are two mechanical characteristics of tissue used to compute the mechanical stimulus S, the main parameter of mechano-regulation.

1. What is the effect of this parameter on the growth rate of capillaries during tissue vascularization?

* As the mechanical stimulus, S, rises towards the threshold Smax, the capillary growth rate decreases linearly, reaching zero at S = Smax: a high combination of shear strain and fluid flow prevents capillary vessel formation.
* When the mechanical stimulus is zero, the rate of capillary growth is maximum: low or negligible stimulus permits rapid vascular growth.

Reference

Prendergast, P. J., R. Huiskes, and K. Søballe. Biophysical stimuli on cells during tissue differentiation at implants interfaces. J. Biomech. 30:539–548, 1997. doi:10.1016/S0021-9290(96)00140-6