

Research on Morphology of Human Red Blood Cells (RBCs) in Different Gravity Fields

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Abstract. By testing fresh human red blood cells (RBCs), the morphology of human RBCs in different gravity fields was observed by SK2109P microscope. And the death rate of RBCs in different gravity fields were counted Results show that: RBCs can endure a certain gravity field. RBCs barely died under gravity fields less than 340g. The death rate increased from 40% to 70% while the gravity field increased from 1360g to 1850g. When gravity field reached 3050g, the death rate became over 90%, it was hard to find survival cells in viewing field.

Introduction

Supergravity can be obtained by centrifugal round and has been extensively used in cropper seed selected, microorganism variation [1-3], and it is also significant to medical research. Caused by launching and returning spacecrafts, the supergravity attracted interest of researchers after Apollo successfully landing on the moon. Natalia M. Arzeno [4] found cardiovascular deconditioning was still evident 6 days after returning from short-duration spaceflight, and parasympathetic modulation was diminished and sympathovagal balance was increased. Nadège Minois [5] reported the age shortened while prolonged exposed in the supergravity fields. Considering the effect on human body of supergravity fields, researchers have studied the countermeasure. Ana Diaz [6] designed a compact rotating centrifuge to research physiological deconditioning during space missions by making an artificial supergravity. The similar research worked by Yifan Yang [7] showed that artificial gravity is a potential countermeasure against the microgravity in space.

RBCs is the mian part of blood, their role was transport oxygens to support the life. Therefore, morphology of RBCs in supergravity fields has a direct influence on human supergravity training. This paper used human rad blood cells (RBCs) as an object, to research the effect of the supergravity on morphology of RBCs.

Materials and Methods

Choose fresh human RBCs as test materials and deal with rotating speed adjustable centrifuge (LD4-2A), which radius is 13.5cm and the maximum rotational speed is 4500r/min. Observe morphology and count the death rate of RBCs dealt with and without spuergavity fields. The equation between rotational speed and the gravity is as shown in Eq 1.

$$G = \sqrt{g^2 + g'^2} = \sqrt{g^2 + ((2\pi n)^2 r)^2} \quad (1)$$

g is the normal gravitational acceleration, r is the radius of the centrifuge, n is the rotational speed. G is the super gravitational acceleration. The calculated result was showed in table 1.

Results and Discussion

Fig.1 shows morphology of RBCs under different gravity fields. Fig.1(a) is the morphology of RBCs under the normal gravity. It shows that RBCs are smooth sphere with dark centre because the normal RBCs are concave in the centre which decreases the light reflection.

Under the 37g supergravity field, morphology of partial RBCs changed, cell membrane shrank and resulted to a rugged cell surface. The proportion of deformed cells increased when the supergravity field increased to 150g. To 340g, the level of deformation increased but no dead cell was observed. Under 600g supergravity, RBCs died but healthy RBCs can be still observed, so death is not a common phenomenon.

The supergravity fields raised to 940g, 1360g, 1850g and 2420g, the death rate of RBCs increased and large number of dead RBCs can be observed in viewing field. Meanwhile, survival RBCs deformed and healthy RBCs disappeared. When the supergravity reached 3050g, it was hard to find survival RBCs.

The death rates of RBCs in different gravity fields were count with 15-20 viewing fields, and the result was showed in Fig. 2. The death rate was 30% in 600g supergravity field, and it increased slowly to 40% in 1360g supergravity field with unapparent amplification. The death rate increased to 60% suddenly in 1850g supergravity field, Then it increased rapidly with gravity increased. In 3050g the death rate was 90%, there were barely survival RBCs.

RBCs are consist of water and hemoglobin. Under supergravity, the molecular weight of H_2O is less than the hemoglobin's according to Newton's laws. So the gravity dehydrates RBCs firstly which caused deformation and shrink. However, deformation will be recovered and RBCs survive. RBCs maybe die from hemoglobin dissolution(hemolytic phenomenon) because gravity slits cell membranes[9-10]. In this experiment, RBCs deformed but survived in the lower supergravity fields(less than 340g) because of dehydration, and cell membranes shrinks. As the supergravity field increased to a certain value(600g-1300g), cell membranes became slited and RBCs died from emoglobin dissolution. In this process, death rate raised slowly for part of cell membranes have not be slited. To 1850g, cell membranes were slited heavily, so the death rate increased rapidly. In the end, all of RBCs died.

Conclusion

RBCs can endure a certain level of supergravity. They can survived in the supergravity field less than 340g, and dead cells were observed from 600g. The death rate increased slowly untill 1360g, and increased rapidly in 1850g. Since then, with the increase of supergravity field, the death rate increased continuously.

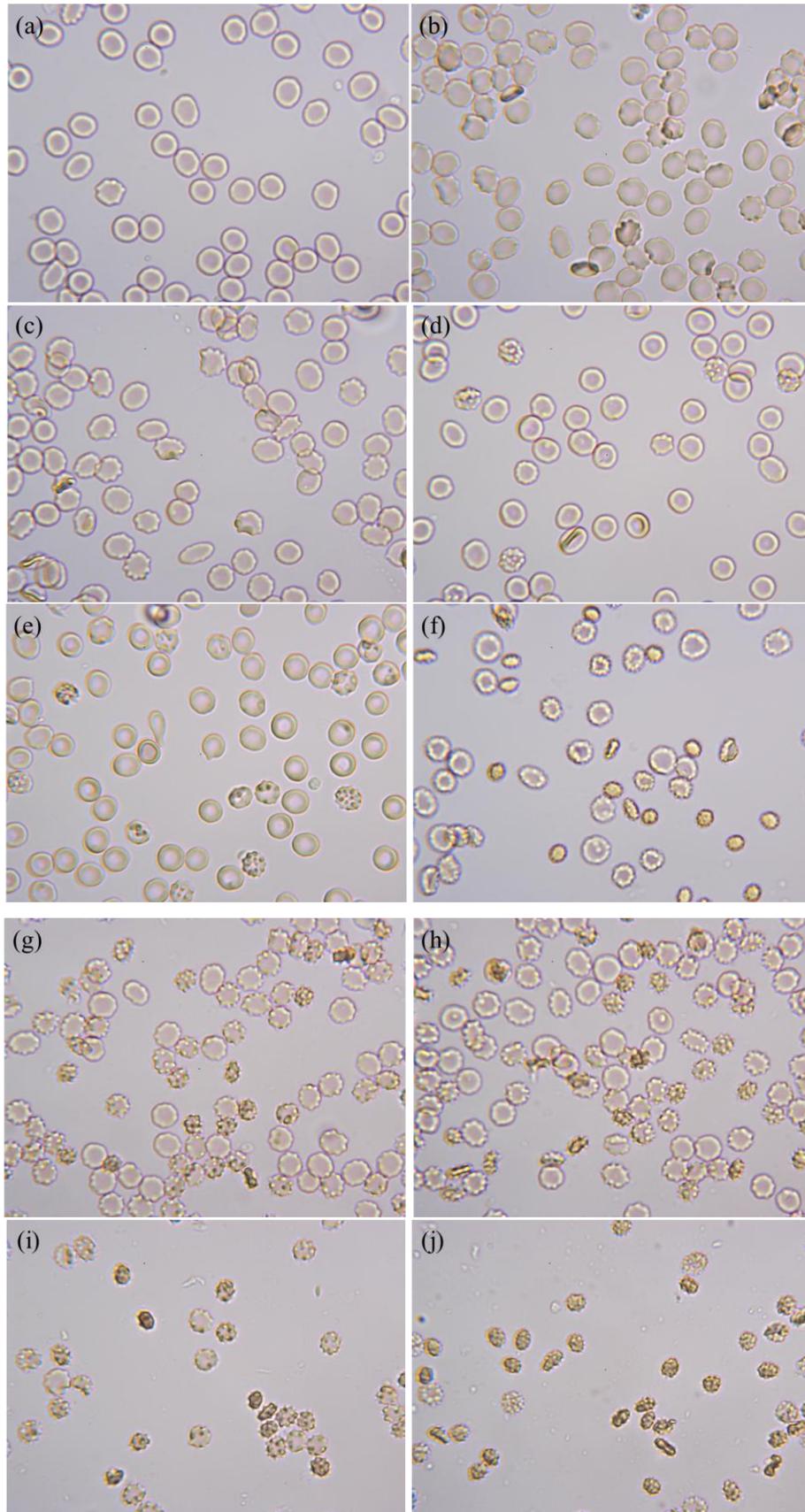


Fig.1 Mophology of RBCs in different supergravity fields
(a)0g (b)37g (c)150g (d)340g (e)600g (f)940g (g)1360g (h)1850g (i)2420g (j)3050g

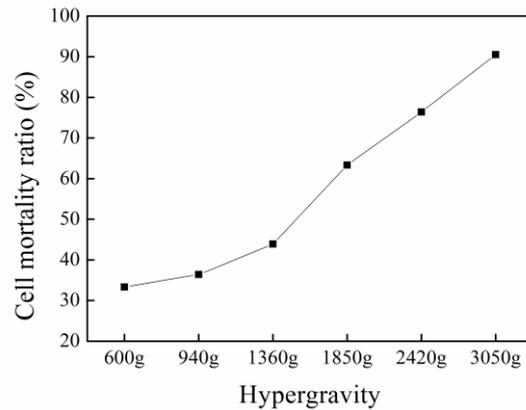


Fig.2 Death rate of different supergravity fields

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