101 (1033)

The shape of the human red blood corpuscle.

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In a paper published in 1909[1] I presented evidence in refutation of the new teaching[2] that the normal shape of the mammalian red blood-corpuscle is cup-form. This evidence included data derived from an examination of the capillaries in the omentum of an anesthetized cat, sections of variously fixed tissues, and hanging drop preparations of fresh blood. The latter, sealed and kept at body temperature, were thought to simulate closely actual conditions in the blood vessels of the living animal. The free central corpuscles of such a drop preparation are almost exclusively of the circular biconcave disc form. In view of all the evidence there seemed to be no escape from the conclusion that the biconcave disc-shape is the normal, the cup-shape the derived, form of the mammalian erythroplastid. But since opinion still remains divided on the point as to what is the original and normal shape—that is, whether cup or disc—additional evidence is demanded. Cogent confirmatory data accrue from observations of the corpuscles in the gelatin solution recently devised by Hogan[3] as a substitute for salt solutions for transfusion purposes in clinical cases calling for relief to a fall in blood pressure. The special point of advantage claimed for Hogan's normal-salt-gelatin mixture is that it has the colloidal constitution of blood plasma, and in consequence is not lost from the blood vessels through secretion and osmotic processes as salt solutions are supposed to escape.

The method of procedure in my investigation was to place the Hogan's solution[4] in an incubator at a temperature of 42° C. Hollow ground culture slides, cover slips, a pipette, and a needle were also kept in the same incubator. The excess above the

[1] *Anat. Anz.*, 34: 16.

[2] Weidenreich; Lewis; et al.

[3] *Journ. Amer. Med. Assoc.*, 64: 9, 1915.

[4] I am indebted to Dr. H. T. Marshall for assistance in the preparation of this solution.

normal body temperature was planned to compensate for the cooling incident to the frequent opening of the incubator and the transfer of the preparation for study to the microscope stage. The microscope was used exposed to direct sunlight, and the room temperature was about 73° F. A ring of vaseline was spread around the depression in the slide, which was then filled with the solution by means of the warm pipette. The finger was then pricked with the needle, dipped into the stock solution in the incubator, blood squeezed into the adherent drop, and the resulting mixture touched to the solution on the slide. The mount was quickly covered with a warm cover glass and placed under the microscope for study.

Many of the corpuscles sink at once in masses to the bottom of the concavity in the slide. Those at the periphery almost instantly form long rouleaux. Occasional complicated groups of rouleaux appear. The individual corpuscles seem somewhat more densely packed and more compressed than in drop preparations of fresh unmixed blood. A rapid preliminary examination revealed not a single indubitable cup-form. Careful searching may discover a few cups in most preparations. Some of the peripheral corpuscles crenate within the space of five minutes, and their number augments for about a quarter of an hour.

The main evidence regarding the shape of the erythroplastids is derived from an examination of the more central, freely suspended, and slowly sinking corpuscles. These are clearly circular biconcave discs. They have a gently quivering motion. Seen in profile they appear dumb-bell-shaped. If a freely moving corpuscle is watched for some time it may be seen to turn upward now one side now the opposite side, in either case showing a central depression. Viewed obliquely such a biconcave disc gives the deceptive appearance of a shallow cup. This optical illusion may account for a certain amount of misinterpretation. The vast majority of the corpuscles remain unaltered at room temperature during the period of observation, the space of an hour. The corpuscles gradually all sink to the bottom of the preparation, but remain disc-shaped, many presenting profile views. A disc may be watched slowly changing into the crenated condition. Placing the slide immediately after preparation on ice for a

moment or two does not apparently increase the number of crenated corpuscles nor the number or size of the rouleaux, indicating that these phenomena are not dependent directly upon a lowering of temperature.

The same technic was employed with several salt solutions (Tyrode's,[1] Ringer's and the 0.9 per cent. "normal"), with essentially the same results. These solutions differ from the gelatine mixture in their effects upon the corpuscles apparently only in that they permit crenation to occur more rapidly and more extensively, and in degrees in the order named. The fact that rouleaux form only in the gelatin solution indicates a closer intrinsic similarity to blood plasma than any of the salt solutions possess.

Cup forms appear most abundantly in ordinary preparations with Ringer's solution when the cover glass is supported by a hair. The explanation that immediately suggests itself is that the floating discs become altered into cups through adjustment to the narrow confines between slide and cover glass. In other words, a cup form is conceived of as a circular biconcave disc which has become pushed out on one or the other of its concave surfaces.

If the above-mentioned solutions, used in the manner described, reproduce sufficiently closely the conditions which obtain within the blood vessels of a living animal, the conclusion is inescapable that the normal original adult shape of the red blood corpuscle is that of a circular biconcave disc as was originally taught. The only conceivable other theoretically more favorable condition is that presented in the mesentery of a living animal; but observations cannot be made without the use of an oil immersion lens, and this involves pressure, which is believed to be the chief factor in the production of cup forms through narrowing the confines to which the delicate discs are compelled to adjust themselves.

[1] *Pflüger's Archiv*, vol. 148, p. 273, 1912.