control. In many cases, however, the changes are mediated by blood constituents, including hormones, like the LCP of *Helix*. We have found indications that in the CNS of *Lymnaea* LCP (mol.wt $\geqslant$ 1500 daltons) is also present (peak 1, see figs 1 and 2A). Further studies are needed to elucidate its function.

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Is the vasospasm following subarachnoidal hemorrhage an immunoreactive disease?

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Summary. Subarachnoidal hemorrhage (SAH) from an arterial aneurysm is often followed by vasospasm which may lead to severe or even fatal ischemic brain lesions. The cause of the vasospasm is still unknown. In the present study it is shown that patients with SAH and roentgenological and/or clinical vasospasm have a significantly higher frequency (52%) of circulating immune complexes in the blood than patients with SAH without spasm (9%). This finding indicates that the vasospasm following SAH may be elicited via an immunoreaction.

The vasospasm following a subarachnoidal hemorrhage (SAH) from an arterial aneurysm often has a biphasic course: a 1st stage with vasospasm of short duration, in connection with the bleeding, and a 2nd stage with long-lasting vasospasm which appears about 1 week after the bleeding. The first vasospasm is possibly mechanically elicited while the second vasospasm is thought to have a chemical genesis. This latter long-lasting vasospasm can cause severe to fatal ischemic brain injuries. The cause of the vasospasm is still unknown. There are several studies which indicate that released blood products with vasoactive effect might cause the vasospasm. A number of such substances have been suggested, such as serotonin, histamin, plasmaproteolytic enzyme, acetylcholine, heparin and others.

The present study is based on the following theory. Antigenic substances are liberated from the site of the bleeding. These antigens are absorbed into the blood stream and will initiate an immune response with formation of antigen-antibody complexes. These immune complexes will in turn cause an inflammatory reaction at certain sites of the arterial tree with release of vasoactive substances leading to spasm. To test this thory the presence of circulating immune complexes in blood was studied in patients with SAH from a ruptured aneurysm.

Patients and methods. The study included 43 patients with SAH from a ruptured aneurysm. Blood samples were taken at varying intervals after the bleeding. Thus samples were obtained before and after surgical intervention with ligature of the aneurysm. Vasospasm was considered to be present when the patient showed angiographic signs of spasm and/or pronounced clinical symptoms indicating an ischemic lesion. There were 2 control groups. One group consisted of 20 patients with other neurosurgical diseases, operated, as well as nonoperated. The other control group consisted of 20 blood donors.

Demonstration of circulating immune complexes was performed by incubating 2×10^6 normal granulocytes prepared as described by The et al.[1] with 100 µl of the patient's serum and 50 µl of fresh normal human serum as a complement source for 90 min. Tests were considered positive only when more than 10% of the granulocytes showed immune complexes.

Results. The percentages of patients showing presence of circulating immune complexes are given in the table. Patients with spasm showed a significantly higher frequency of circulating immune complexes than patients in the other groups.

Discussion. If one accepts that the method used demonstrates the presence of immune complexes, then the frequency of circulating immune complexes is significantly higher in patients with SAH with vasospasm than in patients with SAH without vasospasm. In the latter group the frequency is as low as in the control group consisting of

The percentages of patients showing the presence of circulating immune complexes

	Number of patients	Circulating immune complexes (%)
SAH with spasm	21	52
SAH without spasm	22	9
Other neurosurgical diseases	20	10
Blood donors	20	0

patients with other neurosurgical diseases. This finding does not necessarily imply that our original theory is correct. Thus the high frequency and the high degree of positivity in the SAH-spasm group could be a result and not the cause of the vasospasm. At present we suggest, however, that a positive test in a patient with SAH indicates that this patient runs the risk of developing vasospasm. It is, of course, too early to speculate about the therapeutic implications of the observation. The possibility, however, of preventing or treating vasospasm with immunosuppressive methods is an alternative that naturally presents itself.

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A Laser-Doppler-Velocimeter using an optical fiber and its application to local velocity measurement in the coronary artery

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Summary. A Laser-Doppler-Velocimeter with an optical fiber has been developed to measure arterial blood velocity accurately in a small sample volume. After fundamental experiments to evaluate the accuracy of the present method, blood flow velocity was measured in canine coronary arteries.

A Laser-Doppler-Velocimeter (LDV) may be an excellent tool for measuring the blood flow velocity accurately in a small sample volume. The practical application of the LDV to medical and biological fields, however, has been restricted to the measurement of the flow velocity in a vessel with a thin wall and/or a small diameter[2-7], because of the relatively low transparency of blood and the vessel wall for the laser light. In order to apply the LDV to the observation of arterial blood flow velocity, we have developed a LDV using an optical fiber as a light guide into the artery. We particularly intended to apply our method to an analysis of the local velocity in a relatively small artery, which has not been possible so far by other methods. After fundamental experiments to evaluate the accuracy of the present method, local blood flow velocities were measured in coronary arteries of mongrel dogs.

Methods. The basic optical system of our LDV is shown in figure 1. The He-Ne laser beam (632.8 nm, 10 mW) is divided by a beam splitter (BS). Half the initial light passed by the BS is focused onto the entrance of a graded-index multimode fiber (100 μm diameter) and transmitted through the fiber into a blood stream. A part of the light back-scattered by flowing erythrocytes is collected by the same fiber and is transmitted back to its entrance. The other half of the initial light divided at the BS is used as reference beam. A frequency shifter (40 MHz) is interposed on the path of the reference beam to differentiate the forward flow from the reverse. The optical heterodyning is made by mixing the Doppler shift signal from the moving erythrocytes with the reference beam. The photocurrent from the photodetector (APD) is fed into a spectrum analyser to detect the Doppler frequency. The dimensions of the measuring head (plastic holder) are 7 mm in length and 3–5 mm in outside diameter (see fig. 3).

Results and discussion. To evaluate the accuracy of the present measurement, known blood flow velocities in a circular groove on a rotating turntable were measured at various revolution speeds. The fiber was inserted into the blood stream at an angle of 55°. In general, the power spectrum of the Doppler shift frequencies was almost flat from 40 MHz (corresponding to zero velocity) to lower frequencies (higher frequencies for the reverse flow) and then fell to the shot noise level (see the spectrum pattern in the left side frame of fig. 2). The reason for the broadening is that the blood flow is disturbed locally at the fiber tip and the back-scattered light includes the flow information

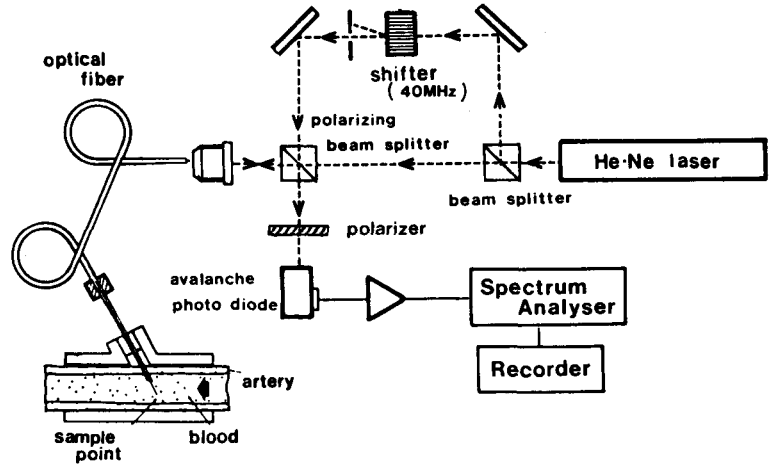

Figure 1. Experimental setup of a Laser-Doppler blood Velocimeter.