A NEEDLE PUNCTURE SYSTEM FOR AUTOMATIC BLOOD SAMPLING

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The many procedures of blood test have been automated and the test system is developing on a tip size substrate such as μ-TAS. Achievement of automatic blood sampling system combined with automatic blood test system may be expected to decrease sampling volume of the blood and to realize home blood test [1]. As a part of automatic blood sampling system, we developed equipment for needle puncture that measured force acting on the needle tip and electric impedance. To obtain the needle tip pierced into the blood vessel, the changes in puncture force and electric impedance were evaluated. We carried out experiments of needle puncture to rabbit's ear vein.

The needle was set on a device for measuring puncture force puncture force by using a loadcell, and moved by a linear stage. A current electrode and a detection electrode of impedance meter were attached to the skin. The other electrode of each pair was connected to a Teflon® coated wire with a bared tip that was placed inside the needle. When the needle punctured the vein, blood flowed into the needle and caused a short circuit. The change in electric impedance from the open circuit to the shorted circuit was measured via a differentiating circuit as ΔZ. The puncture experiments were carried out on the vein of a rabbit's ear, which was fixed with an elastic bandage. The experimental protocol was designed to minimize pain, conforming to the guidelines for animal experimentation at the Tokyo Medical and Dental University.

The puncture force increased gradually when the tip of the needle touched the skin. Then some peaks in puncture force, caused by piercing the skin and the vessel wall, were observed. The peaks in puncture force varied considerably, and sometimes could not be observed when the skin expanded because of the tension and the vessel being pressed by the needle movement. On the other hand, ΔZ suddenly decreased from zero to a large negative value after the peak of puncture force when the needle punctured the vein wall. We have shown that the moment of puncturing a blood vessel could be identified by blood flowing into the needle and was not affected by the mechanical condition of puncturing. Although a peak of force appeared, ΔZ did not change when the needle punctured beside the vein. It suggests that the combination of puncturing force and ΔZ will provide information on failure to puncture the vein.

REFERENCES

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