Introduction
It is well known, that contact lenses must transmit enough oxygen towards the cornea, in order to allow the cornea to maintain its normal oxygen uptake rate. A minimum oxygen tension of at least 12-19 mmHg (corresponding to a closed eye lid) is necessary to avoid discomfort, swelling of the cornea and other, more severe eye irritations (Fig. 1). Thus the determination of oxygen-transmissibility (Dk/L) and -permeability (Dk) has become very important in the development of new contact lens materials. Usually one form or other of ‘polarographic’ device is used for the determination of oxygen-transmissibility, the most popular method being the one developed by Fatt et al. (1982) and the ISO-Fatt method (ISO 9913-1, 1997; ISO 9913-2, 1997). Since the polarographic method is very laborious and expensive, the oxygen permeability of the lenses (Dk) was calculated by multiplying the Dk/L-value with the lens thickness L.

Aims and scope of the study
Most studies focus on the changes of the eye caused by prolonged wearing of the lens, because Dk/L- and Dk-values so far were considered to be characteristic constants for a given lens material. However, the influence of prolonged wearing on the Dk-value of a contact lens was not known. Is there a relationship between observed changes in Dk-values and a special type of lens material, as well as age and gender of the persons wearing lenses? Are the changes reversible if commercial lens care systems are used? The intent of this study was to investigate these questions.

Basic principles of O₂-permeability measurements
Oxygen permeability (Dk) is defined as the rate of oxygen flux (mL/s) under specified conditions. This process of diffusion can be described approximately through Fick’s first law under assumption of a linear concentration-gradient throughout the membrane. Oxygen transmissibility (Dk/L) is the value for oxygen permeability divided by the partial pressure difference. The Dk-value is expressed in barrer.

Carrying out the experiment
Nine different types of contact lenses (5 from different manufacturers) were used. Each lens type was worn by at least 4 to 6 healthy volunteers of different age and gender for selected periods of time and under exactly defined experimental conditions. The lenses were worn between 1 to 16 hours in a so-called ‘short-time test’ and between 1 to 4 weeks in a ‘long-time test’. For the sake of standardization all test persons had to use exclusively the saline lens-care system and the saline solution had to be replaced every 2 days. For the short-time test the lenses were worn for only one day. All lenses showed a slight decrease in oxygen permeability with time (Fig. 4). All lenses showed a slight decrease in oxygen permeability with time (Fig. 4).

Results and Discussion
Influence of the time wearing the lenses
Seven out of nine lens types showed a small decrease in the Dk-value with time during the short-time test. Especially in the first 2-4 hours a decrease in oxygen permeability was observed. In the long-time test 4 lens types out of 6 showed a decreasing, 2 lens types a slightly increasing oxygen permeability with time (Fig. 4). All lenses showed a slight decrease in oxygen permeability during the overall test period (short-time + long-time test) (Fig. 5). However, the changes in Dk-value were small and will not be the reason for corneal diseases.

Influence of protein-depositions - cleaning the contact lenses
The changes are mostly due to deposition of proteins and other substances on the lens surface (Fig. 2, 7). But not in all cases deposition of proteins also leads to a decrease in oxygen permeability (Fig. 8). Though oxygen permeability is improved by the use of commercial protein cleaning solutions, the Dk-value of a new lens could not be reached again (Fig. 9).

Influence of gender
If the results of all lens types obtained in the long-time test were compared, a significant lower decrease in oxygen permeability was observed when the lenses were worn by women.

Influence of the volunteers age
There is no significant influence of age of the test person on the changes in Dk-values.

Literature
2. DIN EN ISO 9913-1, November 1997; DIN EN ISO 9913-2, November 1997
8. 1...