Research letters

A new generation of facial prostheses with myoelectrically driven moveable upper lid

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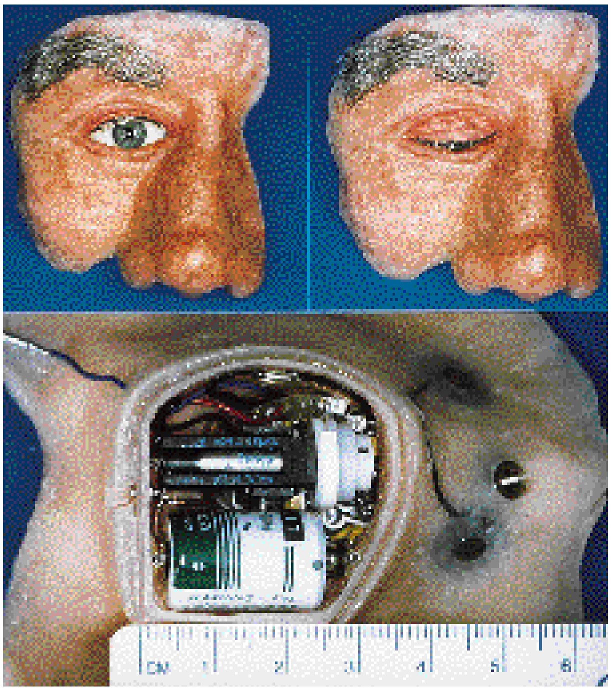
The patient with facial defects after tumour resection or trauma suffers, in addition to the lesion itself, severe psychological stress.[1] The surgeon must restore the face aesthetically and, if possible, functionally so that the patient can lead as normal a life as possible.

When patients have lost an eye and the eyelids, reconstructive plastic surgery cannot satisfactorily replace them with autogenous tissue.[2] Better aesthetic-defect coverage is achieved in these cases with an orbital prosthesis retained with bone-anchored implants.[3,4] However, when the upper eyelid on the healthy side of the face closes, the non-mobility of the facial prosthesis becomes conspicuous.

To overcome this, we developed an implant-anchored silicone facial prosthesis with an artificial upper eyelid that closes simultaneously with the upper lid of the healthy eye.

A specially designed elastic membrane made from latex served as the moveable upper lid. It was cast with plaster forms adapted to the individual glass eye prosthesis. The lid opening was an active movement effected with a polyamide thread fastened to the lid's reinforced edge. Closure occurred from the elastic energy that was stored in the membrane. The thread, running through a cannula behind the eye prosthesis, was spooled onto a roll by a tiny DC-micromotor. The long-run durability test (300 000 blinks) showed no fatigue phenomena of membrane or mechanics.



Facial prosthesis from the front with open and closed artificial upper eyelid and from behind with the inner workings, acrylic cover removed

The electronics for processing the muscle potentials and driving the motor were located behind the eye prosthesis on two doublesided circuit boards constructed in surface mounted device (SMD) technology. One board amplified the potentials and after a threshold value comparison conducted them further to drive the motor, mounted with a battery with 950 mAh nominal capacity on the second board. The components were encased in a solid acrylic capsule, which was integrated into the silicone prosthesis.

To release the artificial-lid motion and synchronise it with the healthy eye, muscle action potentials were picked up from the orbicularis oculi muscle and directed over a fine cable to the electronics. This was done in a bipolar procedure. The first electrode in the form of a needle electrode contacted the muscle. The second electrode was fixed to an implant-anchored magnet with electrical contact to the tissue. Only the signal difference between the two electrodes was amplified and processed. The third implant-fixed magnet served as earth terminal.

The first patient to be fitted with the new prosthesis had an extensive midfacial defect after tumour resection. The facial prosthesis was retained with three Brånemark implants and magnets. The new prosthesis was about 30% heavier than the conventional prosthesis, however this increase did not become apparent to the patient. The cosmetic result was good. The artificial upper eyelid moved simultaneously with the healthy eye. The synchronisation was tested with video control in slow motion. With additional movement of the artificial eyelid the patient presented a much more natural appearance. The unnatural rigidity of the conventional facial prosthesis has been overcome.

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