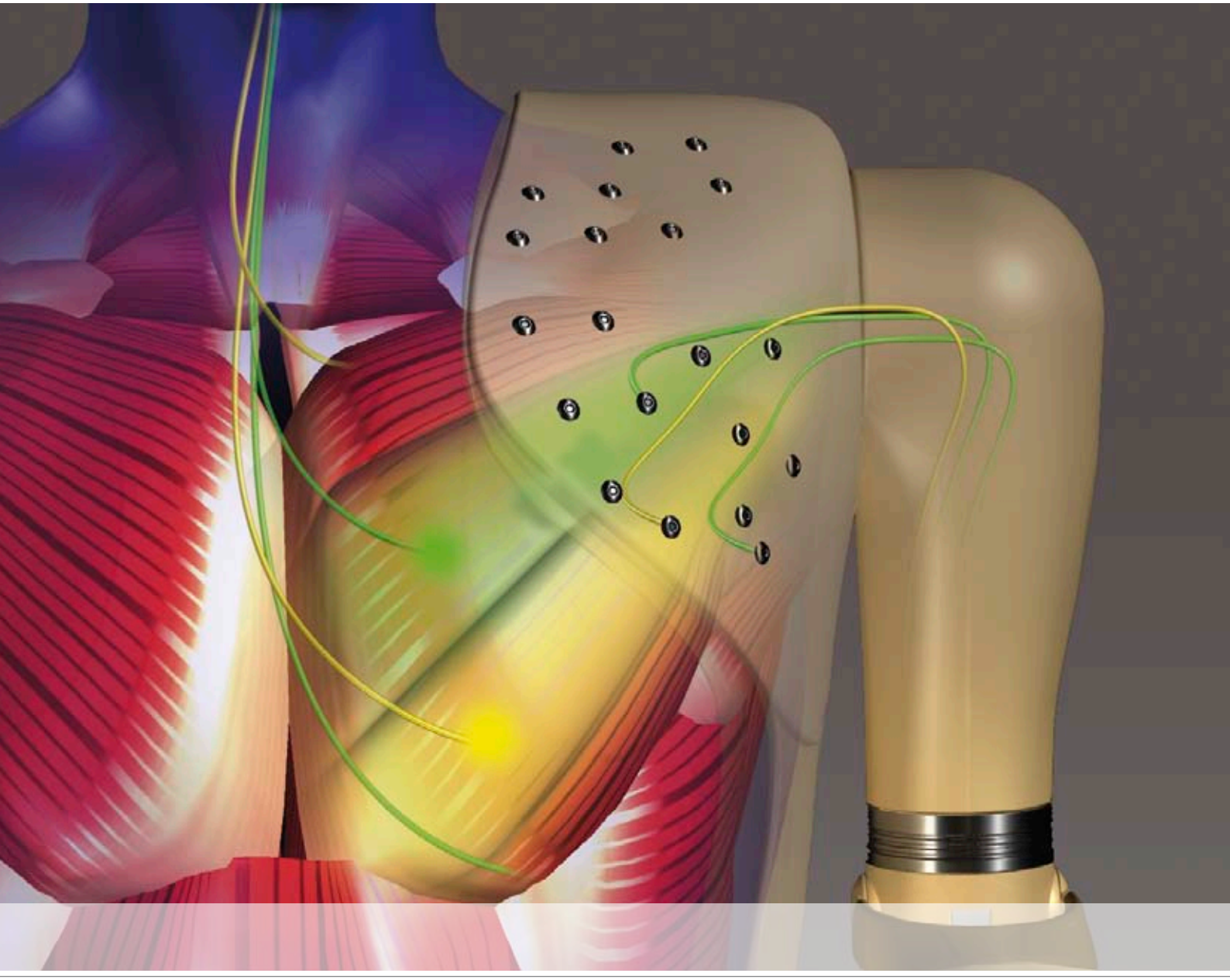
Otto Bock®

QUALITY FOR LIFE



Targeted Muscle Reinnervation

Information for Practitioners

A Revolutionary Development: Present and Future

The new kind of intelligent upper limb prosthesis means a tremendous progress compared with existing fittings. It can be controlled using the same nerves originally responsible for arm movement. The prosthesis currently offers its user three degrees of freedom, i.e. three active joints that can be controlled simultaneously. After implementation of the new Axon-Bus® Prosthetic System, it will be possible in the future to simultaneously control up to seven active joints. In conventional myoelectrically controlled prostheses it has been possible up to now to control three degrees of freedom separately and one after another.

Targeted Muscle Reinnervation

The new TMR prosthesis enables the user to make more natural movements because the active joints can be controlled simultaneously. Any rethinking, as is needed with myoelectrically controlled prostheses, is no longer required. The patient performs movements intuitively, and the prosthesis can directly convert the thought commands. In doing so, the user acts with his so-called “phantom arm”, which he can move instinctively in his imagined body perception.

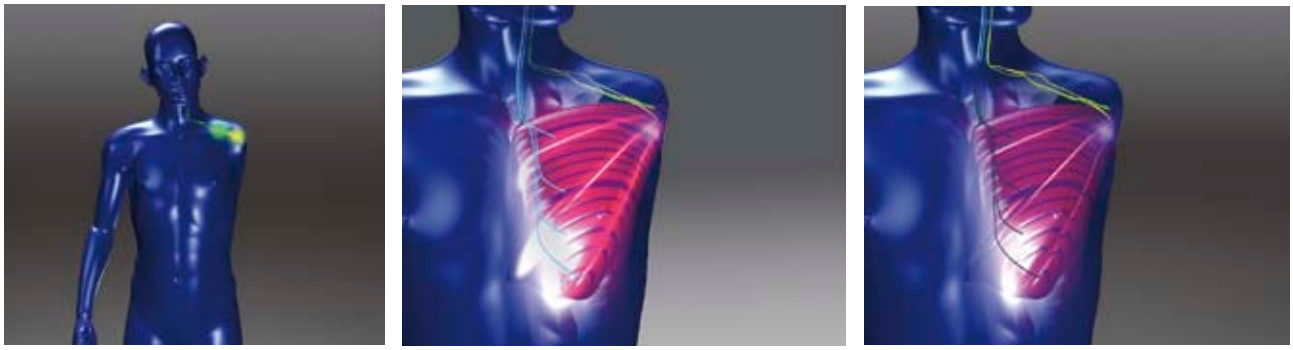
Medical Information

Selective Nerve Transfer: Targeted Muscle Reinnervation (TMR)

This kind of fitting requires prior surgical intervention in which the arm nerves are redirected. TMR is the medical term for nerve redirection. As part of the so-called targeted nerve transfer, the remaining nerves from the limb are connected to a muscle which is suited to amplifying the motor information sent from the brain. In this way, the signals that originally had been responsible for arm movement can be used to control the prosthesis. During the healing process following the operation, the nerves form new connections with the surgically segmented target muscle.

Highly sensitive electrodes are integrated into the prosthetic socket to receive control signals. A complex electronic analysis process within the prosthesis converts the received signals and identifies the desired movement. This enables the user to intuitively control the movements of the thought-controlled prosthesis.

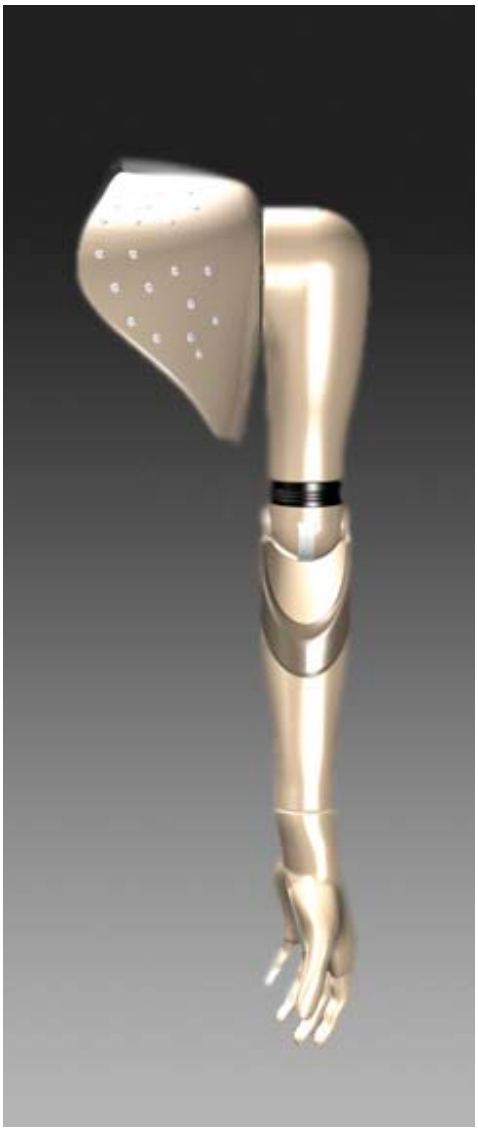
Up to now, this method has been used only for shoulder disarticulation amputees. It is currently being tested whether it will be possible to use this procedure in the future for other amputation levels as well.



Comparison

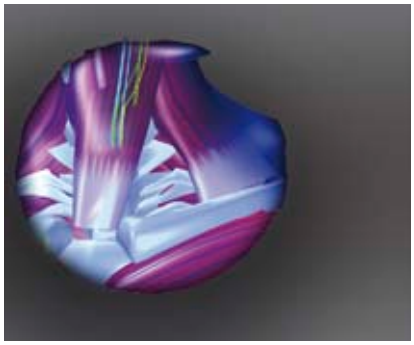
Intuitively controlled TMR prosthetic fitting

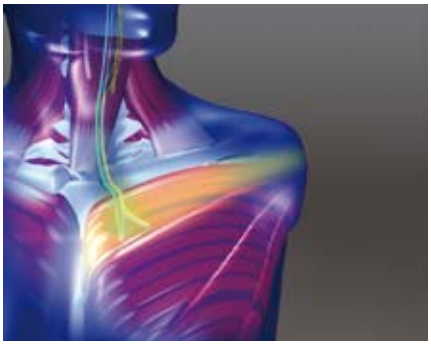
- The number of controllable prosthetic joints can be larger than in typical fittings (later up to 7 degrees of freedom/active joints)
- Patients make use of additional signals for controlling the prosthesis
- Additional control signals are gained by transferring the original hand functions to a selected target muscle (Targeted Muscle Reinnervation)
- Using modern electronic analysis procedures, the movements of the phantom arm are recognized on the target muscle
- The movement of the phantom arm is transmitted to the prosthetic arm
- Thus, the patient can control the prosthesis intuitively and in several joints simultaneously.

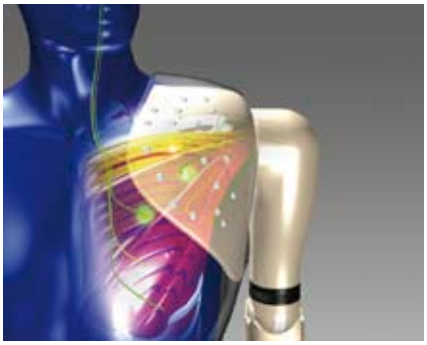


Myoelectrically controlled prosthetic fitting

- Up to 3 degrees of freedom/active joints
- Muscle signals available on the patient's residual limb are used for controlling the prosthesis.
- Patients must select the joint they want to control.
- The joint is selected by switching.
- Switching is frequently performed through co-contraction, simultaneous tensing of agonist and antagonist (e.g. flexor and extensor)
- This allows patients to move individual joints of the prosthesis one after the other (hand, wrist, elbow joint)







TMR Fitting Process

Prerequisites

Patient profile:

- An assessment of the patient's physical suitability must be performed.
- The patient is required to be motivated and willing to engage with the technology and the rehabilitation measures.
- The patient must live in a conducive social environment.
- Willing to travel
- Time, patience, and stamina are needed during post-surgery training (it takes approximately 1 to 3 years for the nerve to grow into the new muscle)

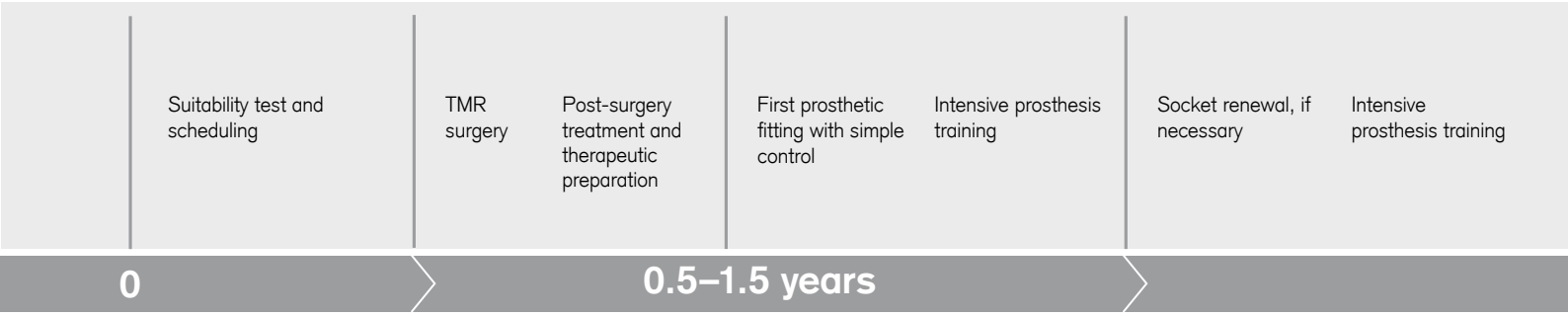
Other requirements:

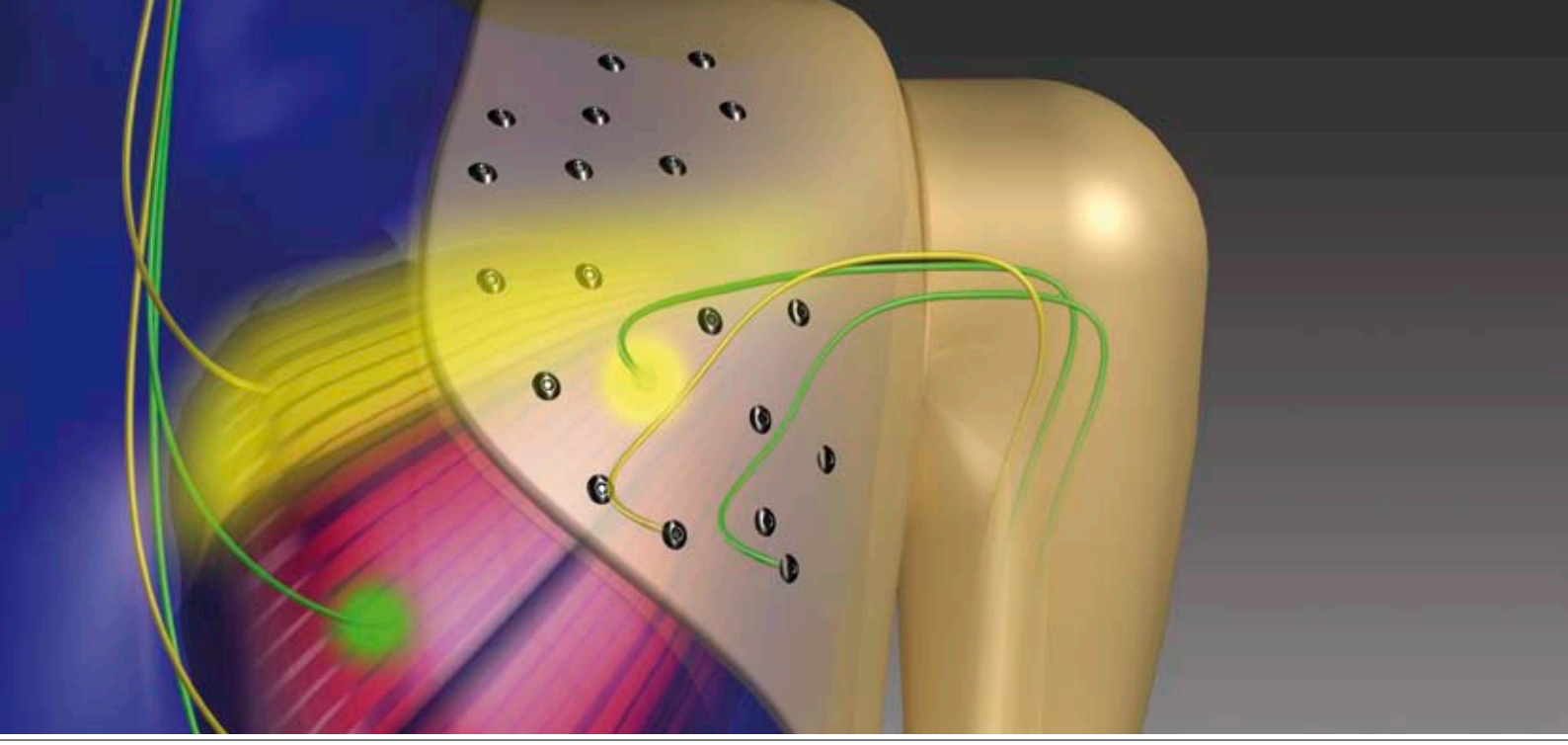
- Communication must be facilitated for foreign patients, i.e. an interpreter is to accompany the patient if necessary.
- Training of an occupational therapist or physiotherapist from the respective country, who will attend to the patient at home in both therapy and technology (approx. 1 week).
- Surgery and fitting are carried out exclusively by the partners/ institutions as a cooperating surgery and fitting team.

Partners/institutions

Clinical:	RIC Chicago, AKH Vienna
Technical:	Otto Bock Vienna/ Duderstadt
Therapeutic:	Otto Bock Vienna/ Duderstadt

Timeline





Benefits

- Intuitive and smooth control of the prosthesis, better corresponding to physiological movement.
- Intuitive, simultaneous control of several prosthetic joints.
- Future possibility for sensing temperature, pressure, and force in the hand is under development.
- ADL-Tests (Activities of daily living) with a bilateral patient have shown that after just three weeks of fitting the reinnervated left side with a TMR prosthesis, performing activities was faster in comparison to the right prosthetic fitting with a myoelectrically controlled prosthesis.

Cost factors

The costs are dependent on the individual conditions and cannot be quantified here.
The following must be taken into consideration when planning:

- Surgery of about 8 hours and hospital stay of 10–14 days
- Follow-up examinations and therapy in Vienna for about 3 months
- Therapeutic treatment in the home country
- Prosthetic fitting depending on the installed components including various socket adaptations
- Additional expenses: e.g. travel expenses, training expenses, expenses for therapy, expenses for an interpreter for patients speaking a foreign language, etc.

Please note

The process described here represents an example of a fitting that takes place under normal conditions and without any complications. Deviations from this example have to be taken into consideration when planning.

Socket renewal, if necessary; repeated measuring and adaptation of the socket with socket renewal may be required	Final fitting	Training for targeted use of the prosthesis	Follow-up care and service check	Follow-up fitting may become necessary
2–3 years				**7–8 years**

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