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# Arm prostheses for children

A guide for parents

Quality for life



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# Foreword



Children are naturally creative and driven by a spirit of discovery. They want to be able to discover and literally grasp their world. Our aim is to give children who lack upper extremities the opportunity to discover their world with both hands alongside their peers. They can experience their everyday lives naturally with two hands with the aid of an early prosthetic fitting. Children are our future and we would like to give them the utmost support in successfully shaping their future.

**“Myoelectrically controlled upper limb prostheses have long been the recognised standard in rehabilitation following an amputation or for arm malformations.”**

By providing optimal prosthetic fittings, we want to find ways to make it possible for children to achieve their goals with one hand or two. Like parents and therapists, we also know how important it is for the development and health of a child to be able to explore the world independently right from the beginning.

An early fitting is of benefit for achieving body symmetry while also enabling the young child to use both hands and arms to explore his or her environment. Two-handed activities are especially important for movement patterns. From a young age, wearing a prosthesis becomes a matter of course for the child and the people around them.

This is why Ottobock offers highly customised solutions for children which are oriented towards their specific needs. At the same time, we know that children are also the most critical users of objects of all kinds. It is therefore important to offer a product that is created with children in mind, both in terms of functionality and design.

We strive to offer highly functional and high-quality possibilities that fulfil the uses required by our youngest fellow human beings through a high level of expertise and expert workmanship.

Expert, empathetic treatment also plays an important role in the success of a prosthetic fitting. For children, parents and relatives make a significant, important contribution through their support and observation of development.

The team of specialists can act as a reliable network to help parents make the development of the affected children or adolescents as unhindered as possible with few limitations.

**Dr. Hans Dietl**

Chief Technology Officer (CTO)  
Otto Bock HealthCare GmbH

# Providing children with prosthetic fittings

## **Why a prosthetic fitting during childhood makes sense**

If you are the parent or relative of a child who has been born with a malformed hand, you may well initially feel overwhelmed by this unusual and sometimes unexpected situation. Sometimes, it can be helpful to remember that this troubled feeling exists only in your own mind – for your child, who was born that way, the malformation is actually perceived as normality. To make sure this doesn't change, it is important that you support your child in his or her special situation, and at the same time offer them ways to master challenging situations better and more easily. A prosthesis offers support for your child's everyday life, both in the case of congenital hand malformations as well as for (traumatic) loss of a hand/arm.

## **The prosthesis becomes totally “normal”**

There are many reasons in favour of fitting children with prostheses. By fitting your child from an early age, he or she becomes accustomed to wearing a prosthesis and to its functions through play. The prosthesis thus feels “normal” and becomes a part of the child in a completely natural manner. In general, babies are initially fitted with passive prostheses – without functions, in other words – but these can be replaced by active prostheses as soon as a child reaches toddler age. Not only does this enable the child to practise dexterity, but it also gives him or her the chance to engage in activities which require the use of two hands.

## **Expert support**

Often it is not easy for parents to decide when and which fitting is best for their child. Together with physicians, therapists and prosthetists, you can discuss the individual options for a prosthetic fitting. Prof. Baumgartner's statement that, “A prosthetic fitting only makes sense if it offers more advantages than disadvantages for the amputee” can be applied to every prosthetic fitting.

## **► Potential advantages of fitting functional prostheses early on:**

- Your child becomes accustomed to wearing a prosthesis and to its functions through play
- Acceptance and dexterity are promoted
- An increased demand on healthy limbs is prevented
- The child is able to engage in more activities which require two hands
- The prosthetic hand contributes to a balanced body image and is integrated into the child's body scheme

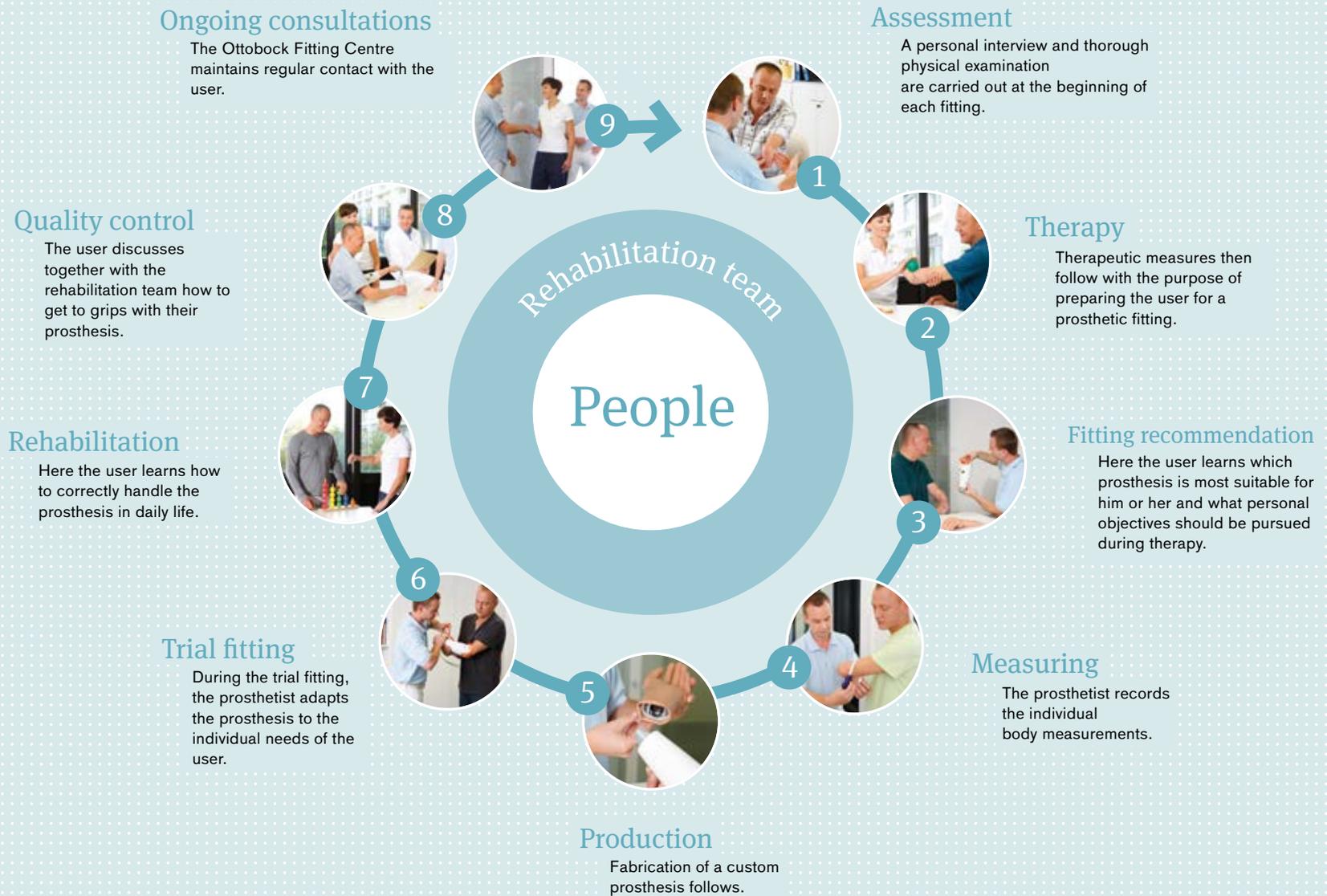
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# Ottobock fitting cycle



# Passive or active hand and arm prostheses?

## **Passive or active hand or arm prosthesis – a comparison**

Your child wants to play, romp and move around. Your child wants to do arts and crafts, build things and “grasp” the world in the literal sense of the word. Children have special requirements with regard to the functionality, flexibility and mobility of their arms and hands, and these present medical technology with special challenges. Not least because these requirements change and increase or decrease in importance as children grow older. This is why it is so important in prosthetics to offer a system which can adapt to the individual requirements of your child at various ages.

## **Passive prosthesis**

Babies and young children are fitted with the Physolino Babyhand in the first few months. This type of prosthesis is suitable for any amputation level. As it has no active functions, it does not contain any control technology and is accordingly lightweight. For this reason, it is also suitable for high amputation levels. An artificial extension of the arm can be particularly helpful for young children as they learn to prop themselves up, crawl or sit up. In adulthood, passive arm prostheses are generally preferred by people for whom a harmonious and natural outer appearance is more important than the functionality of the medical device. Here, the main purpose of the prosthesis is to create a harmonious body image. With regard to function, it can only be used to support objects and provide counter-pressure in certain activities.

## **Active (myoelectric) prosthesis**

Active arm prostheses are controlled by tensing the user’s hand or arm muscles. Due to biochemical processes, moving a muscle (Greek: mys) produces an electrical voltage in the muscle. This is measured on the skin using sensors integrated into the socket and is used to control the prosthesis. An upper limb prosthesis controlled by actively contracting the musculature is thus called myoelectric control. With an active arm prosthesis, two electrodes (sensors) are typically applied to the skin in such a way that they can measure muscle contractions and thus control movement. Put simply, one electrode is responsible for opening and the other for closing the prosthetic hand. This means that the user can now not only hold or support objects, but also actively grip once again. Because myoelectric prostheses look very natural and are comfortable to wear, they have become standard in upper limb prosthetics.



“Children have special requirements in terms of functionality, flexibility and mobility.”

# A focus on activity

When fitting a myoelectrically controlled prosthesis, the primary aim is for the user to be able to actively use the prosthetic hand in everyday life. Hands, however, are very complex prehensile organs, so the technological requirements when making a replica are accordingly high. A prosthetic hand has to be easy to use, robust and reliable, highly functional, have a long service life, and offer a high gripping speed and force.

At the same time, it has to be as light as possible, use as little energy as possible, and look as natural as possible. In order to fulfil these requirements to the greatest possible extent, Ottobock focuses on the natural three-finger “pinch grip” in its prosthetic hand system for children to enable simple, reliable opening and closing of the hand.

- ◉ **The company's portfolio for the passive and active children's hand system has been continuously adapted and further developed for children's everyday lives. Both systems can be adapted individually and gradually to match the age and size of the child.**



# Ottobock hand options for children

## Requirements of a prosthesis

Regardless of whether a prosthesis is active or passive, the most important thing is that it fits properly and is comfortable to wear. As soon as pressure sores develop, the chance of your child accepting and wearing the prosthesis decreases.

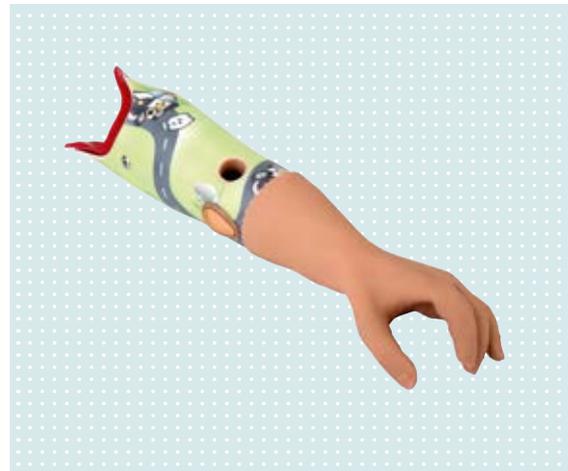
The inner socket of the prosthesis is made from a soft silicone material to ensure it fits as snugly and comfortably as possible over the residual limb. It's this inner socket which actually connects the residual limb with the prosthesis. A robust

outer socket is then fitted over the soft inner socket and fixed in place with screws. This outer socket is in effect a sleeve with the function of providing the prosthesis with stability while remaining as light as possible at the same time. If the prosthesis is too heavy, the child might also refuse to wear it. In the case of an active prosthesis, the components of the myoelectrical control system also lie in the cavity of the outer socket, where they are well-protected. Finally, the prosthetic hand is connected with the socket.



### ► Physolino Babyhand

Passive prosthetic hand for length compensation of the hand or arm.



### ► Active forearm prosthesis

An active forearm prosthesis consists of...

- Hand with prosthetic glove (electrically powered)
- Wrist joint (passive movable ball wrist joint)
- Prosthetic socket (inner and outer socket)



### ► Active upper arm prosthesis

An active upper arm prosthesis consists of...

- Hand with prosthetic glove (electrically powered)
- Wrist joint (passive movable ball wrist joint)
- Elbow joint (passive)
- Prosthetic socket (inner and outer socket)
- Shoulder strap for fixing the prosthesis to the body



“When she and her brother Lukas are playing outside, they both forget the time.”



# Hurricane Celina

Celina was born without her forearm. At six months old she received her first prosthesis, a plastic hand. She could support herself well with this hand. After the plastic hand, Celina received a passive prosthesis before being fitted with a myoelectric prosthesis that had just one electrode. Celina learned physiologically good posture and the correct handling of the prosthesis at an early stage in occupational therapy.

This helped Celina, among other things, to quickly integrate the prosthesis completely into her body image. She wears her current myoelectrically controlled prosthesis with two electrodes – just like her previous prostheses – from morning to evening,

except when it's pinching because Celina has grown a bit more and a new socket needs to be made. In nursery, Celina stands out most due to her vivaciousness. She loves to make the best things. She also really loves riding her bike – still on stabilisers – or scooter around her neighbourhood.

Both she and her brother Lukas forget the time when they're playing outside. But if nothing else, the siblings finally do come home looking for something to eat. And when they're both at home, their mother has her hands full keeping the energetic duo in check. The pair really love playing tag in the house – ideally around the dining table. And who is actually “tagging” whom?

# Supporting the child in everyday life

## **Support through therapy**

Following amputation or malformation of the hand or arm, imbalances with regards to musculature, coordination and balance deficits, as well as unphysiological movement patterns can develop over time. Specialised therapists observe and support the child's growth as well as their motor development, movement sequences and how they use their body. They advise and support the parents, act as a point of contact and interface to other specialist groups. Early treatment from a physiotherapist or occupational therapist is recommended regardless of the prosthetic fitting and accompanies the child in their development.

## **A constant companion, step by step**

Once the mutual decision in favour of prosthetic fitting has been made, the child, their parents and those around them gradually become accustomed to the prosthesis.

- First, the child becomes acquainted with the prosthesis. Depending on the age or necessity, a passive prosthesis can be used at the beginning.
- Regardless of the prosthesis type, an optimum fitting by the prosthetist is of great importance. Only a properly fitting prosthesis which does not cause pain or pressure sores will be accepted and worn.
- The child is then supported in “discovering” the prosthesis functions and thus its benefits. The child learns to control their active prosthesis by contracting their musculature. Curiosity and attentiveness are kindled during this phase and motivation is boosted.
- The child actively uses their new helping hand while having fun and thus gradually acquires the necessary control. One- and two-handed processes are thus increasingly integrated and automated in everyday life.
- There are sometimes identification difficulties both in early childhood and during puberty. It is particularly important in these phases to offer the child the necessary support.

“I find a prosthetic fitting in infancy very important in order to get the child used to the situation and prevent long-term postural defects. Children should be acquainted with the prosthesis and encouraged to use it not only in therapy but above all at home as well. The parents are a very important factor for a successful prosthetic fitting.”

Daniela Wüstefeld, occupational therapist

#### **Using passive prostheses in childhood**

Fitting with a passive prosthesis can be begun as early as the first few months before the child learns sitting balance. During this time, the child discovers their hands and feet and learns to independently grab for objects and adopt a supporting position. For the child, a passive prosthesis in this life phase is intended to be used as support and an option and thus become integrated into the child's body scheme and prevent incorrect posture. At the same time, the child becomes accustomed to wearing a prosthesis and integrates this into everyday activities.

#### **Using active prostheses in childhood**

The ideal time for fitting young children with myoelectrically controlled prostheses differs on an individual basis. It can begin as soon as early childhood. Support from parents and trained experts is vital here. Above all, a good fitting is dependent upon the child's motor and cognitive development as well as the support of the parents. An early fitting helps to boost acceptance of wearing and using the prosthesis over the long term. The prosthesis is perceived as being a matter of course and helps children to undertake activities that they may have avoided due to only having one hand. What's more, possible subsequent physical problems in adulthood can be prevented.

# Learning through play – prosthesis training in childhood

Adolescents and adults learn through explanations and repeated practice. They listen carefully and then try to implement the information they have heard. But with children, it's different. They learn through discovery, play and imitation. Here, therapists – and, above all, you as parents as well – are called upon to support your child as he or she learns and practises. Training with a prosthesis can be divided into four phases, each of which lasts for a different length of time.

## **Acclimatisation phase**

In the first phase, your child becomes accustomed to the prosthesis. Wearing a prosthesis is something a child has to get used to, because it changes both the weight and length of the arm. In order for the child to become accustomed to the prosthesis, it is important to gradually increase the amount of time it is worn each day. We recommend you create a repetitive routine for wearing the prosthesis and keep a record of successes. This will help both you and your child to get used to the new situation. It's also advisable to stay in touch with your therapist in order to discuss next steps.

## **Discovery phase**

Once your child has got used to the feeling of wearing a prosthesis and feels comfortable with it, the discovery phase begins. During this phase, the child has their first experiences with their new prosthesis. What all can I do with it? Children are naturally attentive and curious when they see the prosthetic hand opening and closing. A therapist will support you so these new experiences can be managed and used in a targeted manner

in future. Opening and closing the prosthetic hand is applied in various situations. In order to achieve the goal of being able to control hand movements as consciously as possible, the child will need to practise what he or she has learned outside the therapy sessions as well.

## **Play phase**

As your child plays, he or she will learn how to gain increasing control over the prosthesis. The more important an activity is to the child, the more they will be motivated to practise. When they pick up their teddy bear from the floor and cuddle it using their prosthetic hand, or build a tower higher and higher with building blocks without it falling over, the child gets excited about what they are now able to do, and their acceptance of the prosthesis increases. During this phase, the main task of the therapist is to show the child which hand should perform which function. The prosthetic hand will generally be used as support whilst the healthy hand grips objects. Both hands learn to support and complement each other perfectly. As a parent, your job is to encourage and support your child in using the prosthetic hand in day to day life.

## **Automation phase**

In the last phase, the conscious opening and closing of the hand firstly becomes automatic through repeated gripping, holding and letting go of objects and is anchored into motor memory. Secondly, the prosthetic hand is integrated in the child's body image. Your child accepts the prosthesis and uses it in everyday life without thinking about it.

“We began treatment at 6 months. Today, my daughter has occupational therapy, physiotherapy and hippotherapy once a week.”

Quote from Denise’s mother



#### Practical tips from an expert

1. Use plenty of **play and craft materials that require your child to use both hands**. Your child will quickly learn instinctively that using two hands is clearly faster and more practical. For example: Pushing a doll’s pram, cutting something out with scissors, removing a cap from a pen, opening a yogurt pot and eating from it, packing and unpacking a school bag, painting Easter eggs, cooking, opening and closing a zip, catching and throwing a ball, transplanting potted plants, carrying a tray.
2. Let your child use the **prosthetic hand primarily as the “supporting hand”**. The primary function of the prosthesis is holding objects rather than gripping them.
3. **Encourage rather than demand!** Praise and support your child when he or she uses their prosthesis in everyday life. Pushiness or constant reminders can create a negative prosthesis experience for your child and result in rejection of the prosthesis.
4. Your child also needs to get used to wearing the prosthesis, the resulting increase in weight and the artificial extension of their arm at first. Ideally, the **length of time and intensity with which the prosthesis is worn** are slowly increased until the child has fully accepted their new “hand”.
5. A sign that your child has successfully integrated the prosthetic hand into their body scheme is when they **use both hands in front of the centre of their body** during crafts or playing.

Elke Walther, MScOT  
occupational therapist

# Denise the sportswoman

“What on earth is that?!” is a question Denise frequently hears from other children. It’s a question she’s grown accustomed to hearing. In reply, she simply removes the prosthesis and explains it patiently to the other children. Denise was born without part of her left lower arm – meaning she also had no left hand. She’s never known any differently, but for her parents – who were unprepared – it was initially a shock. They soon got over their shock, however, and asked their paediatrician what to do next. At the age of eighteen months, Denise was given her first prosthesis. Initially, this was a so-called passive prosthesis. This meant that she could use her prosthesis to prop herself up or support her right hand when grasping objects, but nothing more. Nonetheless, it was important that Denise receive a fitting at an early age in order to develop a sense of balance and support her body symmetry.

Denise was just four years old when she received her first active (myoelectrically controlled) prosthesis. Suddenly she was able to perform actions which came naturally to other children. Arts and crafts, playing with building blocks, picking things up off the floor – all these actions which required mobility in the fingers were suddenly possible.

Denise, her friends, and the other children in her class have grown accustomed to the fact that her right hand looks different to her left hand. And Denise can do everything she enjoys. Which, above all, is sports – in particular, sports which involve speed. In summer, she loves whizzing along on her scooter or bike. But as soon as winter comes and snow falls and the first slopes are prepared, she’s in her element. Then she unpacks her skis and races down the mountains. If she can race against other children, then so much the better. Often, she’s one of the fastest, and has been at the top of the podium after many a race. Then Denise is the centre of attention – not because she wears a prosthesis, but because she’s the faster skier.





“She accepts the prosthesis and likes to use it for things that would otherwise not be possible.”

# Recommendations to parents

Children born with a hand malformation should not be treated any differently than other children because of this. It is often the parents and relatives who are far more irritated than the affected child who was actually born with the malformation.

To ensure this remains the case, it is important to support children in their special circumstances, show them opportunities and the way to smooth the path towards a successful future. A prosthesis offers this kind of support and helps both children and adults to overcome many situations better and more easily.

The traumatic loss of a hand or arm is a sudden change in the life of a child and their immediate social environment. The prosthetic replacement of the hand can take place in this case following completed wound healing and in consultation with the treating doctor.

Regardless of the cause, accompanying therapy by specialised child psychologists is recommended. Doubts, fears or even daily challenges are explored and thus help the family to support the affected child in the best possible way, whether the family decides for or against a prosthesis.



## Outlook and further information

Adolescents and young adults who have already become accustomed to wearing a prosthesis and actively using it during childhood find it easier to transfer to more complex prostheses later on. A prosthesis can significantly expand a child's range of possibilities, particularly in training and professions which require working with both hands. Prosthesis wearers then have the choice of taking up a career which requires manual activities. Knowing that they have the opportunity to choose is a key criterion for young people who are affected.

