

## ORIGINAL REPORT

## A BIONIC HAND VS. A REPLANTED HAND

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**Objective:** Evaluation of the hand function affected when replacing a malfunctioning hand by a bionic hand.

**Design:** Case report.

**Subjects:** One individual that wished for a better quality of life after unsatisfying hand function following a replantation.

**Methods:** A quantitative and qualitative evaluation of body functions as well as activity performance and participation before and after a planned amputation and prosthetic fitting is presented.

**Results:** Improvements were seen in the patient-reported outcome measures (PROMs) that were used regarding activity (Disability of the Arm, Shoulder and Hand [DASH] and Canadian Occupational Performance Measure [COPM]), pain (Neuropathic Pain Symptom Inventory [NPSI], Brief Pain Inventory [BPI], Visual Analogue Scale [VAS]), cold intolerance (CISS) and health related quality of life (SF-36), as well as in the standardised grip function test, Southampton Hand Assessment Procedure (SHAP). No referred sensations were seen but the discriminative touch on the forearm was improved. In the qualitative interview, a relief of pain, a lack of cold intolerance, improved appearance, better grip function and overall emotional wellbeing were expressed.

**Conclusions:** The planned amputation and subsequent fitting and usage of a hand prosthesis were satisfying for the individual with positive effects on activity and participation.

**Clinical relevance:** When the hand function after a hand replantation does not reach satisfactory levels, a planned amputation and a prosthetic hand can be the right solution.

**Key words:** arm amputation; bionic limb; hand prosthesis; hand rehabilitation; hand replantation.

## LAY ABSTRACT

Here we present a case report of 1 individual who wished for a better quality of life after over 20 years' experience of unsatisfying hand function following a replantation. Evaluation of body functions as well as activity performance and participation before and after a planned amputation and prosthetic fitting is presented. Improvements were seen in the patient-reported outcome measures regarding activity, pain, cold intolerance, and health-related quality of life, as well as in grip function test. In the interview, a relief of pain, a lack of cold intolerance, improved appearance, better grip function and overall emotional wellbeing were expressed. The planned amputation and the subsequent fitting and usage of a hand prosthesis were satisfying for the individual with positive effects on activity and participation. When the hand function after a hand replantation is not satisfactory, planned amputation and prosthetic hand can be considered.

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After a substantial trauma to the hand, replantation is, if possible, preferable to amputation (1, 2). The goal is to achieve satisfying hand function, but also a satisfying appearance. Satisfying sensory and grip function is desirable, but full recovery is not to be expected (1), and the quality of life might be affected (3).

Reported survival rate of replanted hands is about 50% (2), but this is not necessarily equal to a functional success or the subjective satisfaction. Factors that are reported to influence the results are level of injury, ischaemia time, age, and smoking history (4). In addition, a replanted hand has changed appearance, because of intrinsic muscle atrophies with subsequent weakness and motor imbalances. Poor discriminative sensibility adds to a limited grip function and such functional limitations can also be amplified by pain and cold sensitivity (1, 4).

Elective amputation of a hand and bionic reconstruction have been done with functional improvements and satisfying results in cases of sequelae after critical soft tissue injuries (5). In a few cases of brachial plexus injuries (6, 7), and in 1 case with arthrogryposis multiplex congenita with severe deficits of the hands, planned amputation and replacement with hand prosthesis with satisfying results have been described (8). However, even if an amputation is wished for, it is irreversible with potential pain problems, and a life-changing decision. After amputation, a prosthetic hand can, to some degree, compensate for the functional loss (9). In addition, a hand prosthesis plays a significant role regarding body image, identity, participation and for health-related quality of life (9, 10).

Here we present a case of an individual who desired better hand function after over 20 years with unsatisfying function following a hand replantation. The patient wanted to get rid of the non-appealing hand and asked for an amputation and a prosthesis to enable better grip function, less pain and to get relief from cold intolerance. A trans-radial amputation was done and he was fitted with a myoelectric hand prosthesis. The objective was an evaluation of the hand function affected when replacing a malfunctioning hand by a bionic hand.

Research questions: How was the grip function affected when the malfunctioning hand was replaced by a bionic hand? How did touch thresholds, tactile gnosis and cold intolerance change in the residual arm? How was the perceived activities of daily living (ADL) and participation affected by the amputation?

## MATERIAL AND METHODS

### *Patient description*

A 28-year-old right-handed man sustained a trans-radial amputation of the left, non-dominant hand as a result of a workplace accident. A replantation was done followed by traditional hand rehabilitation. At age 51, he contacted a hand clinic (not the same where the replantation was performed) because he experienced the replanted hand as a hindrance in ADL and also aesthetically unappealing. He worked full-time as a courier driver. The patient specifically asked if his replanted left hand (Fig. 1) could be amputated and replaced by a hand prosthesis.

### *Presurgical procedure*

Before the decision on surgery, the patient underwent assessments of hand function, and a psychosocial evaluation was



**Fig. 1.** The hands with markings on the left arm at the level of the planned amputation.

done to assess whether there were psychological or emotional hesitations to an amputation. To determine the patient's ability to control the planned myoelectric prosthetic hand, the muscle function proximal to the planned amputation was assessed with surface EMG (electromyography) electrodes (extensors and flexors). A myoelectric prosthetic hand built on an orthosis with an OttoBock Sensor Speed hand, was used at home for 6 months prior to the amputation (Fig. 2), as described by Aszmann (5, 6). This gave the patient the opportunity to get familiar with how to control the prosthesis and was also a strategy to give reasonable expectations regarding grip ability.

### *Assessments and patient-reported outcome measures*

**Body functions.** Touch thresholds were assessed bilaterally with Semmes Weinstein monofilaments (SWM) (11) and tactile discrimination (2PD) (11). To assess the development of referred sensations, touch thresholds and tactile discrimination (on pre-defined points) were also tested on the forearm bilaterally, proximal to the level of injury and the planned level of amputation.

Grip strength was assessed with a Jamar dynamometer (Sammons Preston, Rolyon, Bolingbrook, IL, USA) (11) and pinch strength with a Pinch gauge dynamometer (B&L Engineering, CA, USA).

Function of intrinsic muscles was evaluated using Manual Muscle Strength Testing (MMST) (11).

Pain at rest was estimated on a Visual Analogue Scale (VAS) and 2 questionnaires were used: Brief Pain Inventory (BPI) Short Form (12) and the Neuropathic Pain Symptom Inventory (NPSI) (13).

For problems of cold intolerance, the self-administered questionnaire, CISS (Cold Intolerance Severity Score) was used (14).



**Fig. 2.** The hybrid myoelectric prosthesis with a SensorSpeed hand (OttoBock) applied to the arm in the process before the amputation. This solution gave the patient the opportunity to get an idea of what he could expect from a hand prosthesis.

The Southampton Hand Assessment Procedure (SHAP) (15, 16) and MiniSollerman (17) test were used for the assessment of grip function.

Body ownership was assessed with a Proprioceptive Pointing task (18). A ruler was placed on a screen, where the arm was hidden. The patient (blinded) was asked to mark on the ruler where the index finger on the replanted hand was experienced. A follow up 1 and 2 years after amputation, the test was made with and without the prosthetic hand, and the patient was asked to mark the location of the end of the residual arm, the experienced phantom index finger and the prosthetic index finger.

*Activity.* The Disability of the Arm, Shoulder and Hand (DASH) questionnaire (19), and the Canadian Occupational Performance Measure (COPM) (20) were used.

*Health-related quality of life.* For health-related quality of life, the patient completed the SF-36 (21) questionnaire.

*Semi-structured interview.* Before the elective amputation, the first author carried out a semi-structured interview (22), with focus on experiences regarding the hand. One year after the amputation, the patient was interviewed again with questions concerning experiences with the amputation and the prosthetic hand.

#### *Surgical procedure*

The amputation was performed under general anaesthesia and an axillary block by 2 specialists in hand surgery. The amputation was planned 17 cm distal to the radial epicondyle. The skin was incised creating a volar and a dorsal flap (fish-mouth). The

muscles were transected, and the radius and ulna were divided with a power saw. The radial artery was ligated. The superficial branch of the radial nerve was divided 2 cm proximal of the osteotomy, and embedded in the musculature. The median nerve was macroscopically normal and divided approximately 4 cm proximal of the osteotomy and embedded in the musculature. The ulnar nerve was attached to the skin and had formed a large neuroma; the nerve was transected 4–5 cm proximal of the osteotomy and embedded in the musculature. The flexor and extensor muscles were secured with osteosutures on to the radius.

#### *Prosthetic fitting*

After healing of the skin, the prosthetic fitting process began with liner for compression and shaping the stump. After 3 months, the patient was equipped with a myoelectric hand prosthesis (Sensor Speed hand, Otto Bock). Five months post-surgery, the patient was equipped with a more advanced multiarticulated myoelectric prosthesis (BeBionic, Otto Bock) (Fig. 3).

#### *Follow ups*

Assessments and patient-reported outcome measures (PROMs) were made prior to the elective amputation, and after 6, 12 and 24 months (Tables I and II).

## RESULTS

Pre-intervention assessments showed that touch thresholds were close to normal (11). Slightly increased touch thresholds (SWM 3.61) compared to normal touch thresholds in ulnar nerve innervated skin. In median nerve innervated areas the touch threshold was considered normal (SWM 2.83). Discriminative touch was poor (not measurable) with 2PD > 15 mm at the index as well as the little finger. From preoperatively to 2 years follow up 2PD on the left forearm decreased from 40 mm to 15 mm, as compared to 50 mm to 30 mm on the right side. Touch thresholds were normal at the left forearm after 1 year and slightly increased after 2 years.

Preoperatively grip force was not measurable, and Manual Muscle Strength Test scored 0 as did the MiniSollerman test.

Pain decreased as showed in NPSI, BPI and VAS (see Table II). Cold intolerance was a large inconvenience with the replanted hand, and symptoms that were highly rated were pain, stiffness, reduced grip strength and ache (NRS range 1–8). A total relief of symptoms on cold exposure was seen after the amputation as well as the subsequent problems in daily life as seen in the total CISS score (Table I).

Body ownership test showed a telescoping phenomenon, meaning that the experienced phantom hand come closer to the residual arm. At the 1 year follow up, the phantom index finger was marked 27 cm distally from the olecranon compared to 16 cm at the 2 years follow up. The residual arm end was estimated to the correct length, and so was the index finger of the prosthetic hand. At the 2 years follow up, the arm length was estimated to 0.5 cm



**Fig. 3.** The patient fitted with the BeBionic hand prosthesis 6 months after amputation.

more distally than in reality and the index finger of the prosthetic hand 7 cm proximal of the actual length.

DASH-score improved with a steady improvement during the follow up period well exceeding the MCID of 11–15 (23), see Table I. COPM showed an improvement both regarding performance and satisfaction of the selected activities. SHAP showed improved grip function at 6 month and 12 months (Table I). At 2 years follow up, the patient declined to do the SHAP due to a lack of time.

The health-related quality of life assessed with SF-36 improved after the amputation, with the highest score at 2 years follow up (Table II).

In the interview, the individual expressed that the main reasons for wanting an amputation was pain, cold

**Table II.** The scoring of SF-36 in the 8 subscales.

SF-36 (0–100)	Pre	6 months	12 months	24 months
Physical functioning	70	80	75	80
Role limitations due to physical health	0	0	50	75
Role limitation due to emotional problems	100	0	100	100
Energy/fatigue	30	80	60	50
Emotional well-being	64	92	85	80
Social functioning	75	100	87.5	87.5
Pain	55	80	90	57.5*
General health	75	80	60	80

Higher scores indicate better well-being.

\*At 24 month follow up, the patient reported low back pain that affected the score.

intolerance, weak grip function and the unappealing appearance of the hand. At one-year follow up, the satisfaction of the amputation and the bionic reconstruction was highly expressed. Pain relief, no cold intolerance, a stronger grip with the myoelectric hand prosthesis and satisfaction with the new appearance were expressed, both with and without the prosthetic hand. The quantitative assessments agreed well with the information from the interview (Table III).

## DISCUSSION

The success rate after replantation is often reported in replant survival, but this is not the only adequate measure of success. In this case reported, the hand had survived but function and appearance were unsatisfying. The planned amputation more than 20 years after the replantation and the subsequent fitting and usage of a myoelectric hand prosthesis had highly positive effects on activity, participation and health-related quality of life.

The first choice when a hand is amputated is, if possible, always replantation. The delicate hand function and sensibility are impossible to fully replace with hand prostheses today, and a “bad hand” may be more functional than an amputation (24). A review (25) describes advantages of replantation, regarding functional results, satisfaction rate and quality of life, in comparison to prostheses. However, a replantation of a hand does not always reach the desired functional results. The level of injury, ischaemia time, age, smoking history, etc., influence the results

**Table I.** An overview of the results from PROMs and functional assessments.

	PRE	6 months	12 months	24 months
NPSI (Total) (0–1)	0.27	0.23	0.19	0.08
BPI-SF (median) (0–10)	3	1	0	3,5*
Pain in rest (VAS) (0–10)	4	5	2	1
CISS (4–100)	76	4	4	4
SHAP (LIF score) (0–100)	22.49	38.10	30.74	-
				Pt declined
COPM (performance/satisfaction) (1–10)	3.8/4	8.5/8.5	8.5/8.5	7/7.2
DASH (0–100)	46	21	15	13

BPI: Brief Pain Inventory; CISS: Cold Intolerance Severity Score; COPM: Canadian Occupational Performance Measure; DASH: Disability of the Arm, Shoulder and Hand; NPSI: Neuropathic Pain Symptom Inventory; SHAP: Southampton Hand Assessment Procedure; VAS: Visual Analogue Scale.

There are improvements in all assessments. In NPSI, BPI, VAS, CISS and DASH, a lower score indicates improvements and in SHAP and COPM, a higher score is better. IN SHAP normal hand function is regarded as equal or above 100 points, and in COPM maximum score is 10.

\*At 24 month follow up, the patient reported low back pain that affected the score in BPI.

**Table III.** The results from the semi-structured interview, analysed with qualitative content analysis, presented in categories and illustrated by quotations in *Italic*, preoperatively and and at 1 year follow up

Preoperative	1 year follow up
<p><b>Grip function /Fine motor /Dexterity</b></p> <p>Loss of grip function was experienced preoperatively but was enabled with the prosthetic hand.</p> <p><i>Non-existent (B). It's in the way actually, I'd say. I have no use of it in fact. If, like, I need to support something or carry something, if I take something light and squeeze it against my body or so then it is of some use. I can't do the things I would like to do properly, tie shoelaces ... (A)</i></p> <p><i>I go out with friends but I can't select a dish that I would like. I have to take something like pasta which is easy to eat with a fork or a pizza slicer. I would never in my life ask anyone else to cut things up for me! (P)</i></p> <p><i>I used to drive a motorbike before. I can't do that anymore now. I can cycle and that's a positive (A). I used to go out dancing quite often once upon a time but that doesn't work now – you need two hands for that. (P)</i></p>	<p><i>It's a hundred times better than what I had before in that I didn't have any grip function so ... it's turned out to be really good. There's a lot to learn, but things are moving slowly but surely forward (B).</i></p> <p><i>It makes a lot of things in everyday life easier (A.) I'm going to take up hunting and kayaking again, I'll start hunting and then I'll hold the barrel of the gun against the prosthesis. It works. It'll be exciting. I thought all that was over (P).</i></p>
<p><b>Strength</b></p> <p>A non-existing grip strength was experienced preoperatively, but was satisfying with a prosthetic hand.</p> <p><i>Non-existent (B). My arm gets tired. I have to, you know, squeeze in the fishing-rod here and I get very tired after a while and then I'm in pain and then I have to rest for a bit. It's the same with gardening – do something different in between where I only need one hand. (A)</i></p>	<p><i>It's quite alright. If I want a better grip I put on the other prosthesis (SensorSpeed, Ottobock). Then it's almost too good. Yes, much stronger. But this one (Bebionic, OttoBock) is really enough. If I have gripped something well I don't let it go. It doesn't press too hard, but if you've got hold of something properly it stays in place. It simply doesn't open up (B).</i></p>
<p><b>Sensibility</b></p> <p>Hypersensitivity was experienced preoperatively but not after the amputation. Instead, the patient expressed some kind of sensory feedback with the prosthetic hand.</p> <p><i>Over-sensitive, tingling feeling. It doesn't affect very much, it's just an unpleasant feeling. Yes, it's hard when I move my hand. It's an unpleasant feeling. It's extremely unpleasant. I use a glove or splint which presses against it, and that way I don't feel it. It tingles, or feels over-sensitive ... like, when my hand has gone to sleep and is waking up again (B).</i></p>	<p><i>I've learned to find something which I react to when I'm driving a car. There are a lot of controls on the left-hand side, and I've taught myself to find them. Like when I'm reaching for them I feel that I'm touching something small ... then I feel it in my stump. Then I feel that I'm in contact with the indicator and I activate it. So in some strange way you feel things anyway (A)</i></p>
<p><b>Pain/Phantom Limb Pain</b></p> <p>The preoperatively phantom limb pain was still present but alleviated postoperatively.</p> <p><i>It really hurts a lot as soon as I knock against something, the smallest thing I do. I'm in pain on and off, almost the whole time. When I don't do anything, phantom pains can come occasionally – it's just as if I am pressing very hard against something, then I get a shooting pain inside my hand – it's just as if someone is pressing really hard here and then I feel it out into my hand. It's that feeling of pressing, stabbing and tingling. Then I try to shake my hand a bit, but, of course, it doesn't help ... but it usually lasts for a few days and then it calms down. I try not to think about it. You get used to it. You have to live with the pain. Now it's been a very long time since I had it (B).</i></p>	<p><i>Certain pains you can live with. This is nothing that worries me very much. I'm beginning to get over the difficulties I had getting to sleep before. (B)</i></p>
<p><b>Cold intolerance</b></p> <p>Pain and skin colour change were experienced during and after cold exposure during all seasons preoperatively, although relieving strategies were found. After the amputation, no problems were expressed.</p> <p><i>I get cold and that makes it hurt. The thing about the cold is hard. It doesn't have to be very cold outside. It's enough if it's something like 8–10 degrees centigrade outside. That's enough for it to get cold. The whole hand hurts ... (B). I get cold and it's even turned blue and then the pain really comes. It usually comes when it starts to get warm again. That's when the pain comes (B). I really thrive on outdoor activities, being out in nature, fishing, working in the garden, walking ... (A). I try to protect myself as much as possible. I do have gloves on. Often it comes on during the day when I'm working. If I'm out and need to undo things and it's cold outside and that, then it can last a long time. I stuff it in my armpit, like, the best place to get it warm. Although I can't keep it there all the time. (A)</i></p>	<p><i>No, none. (B)</i></p>
<p><b>Appearance</b></p> <p>From being ashamed, hiding the hand and never showing it outside the family, the patient became very satisfied and proud with the appearance after the amputation, both with and without the hand prosthesis.</p> <p><i>You just have to look at it. If I go to town I scare people to death. That's why I wear a glove. I don't like the way it looks. I'm ashamed of it (B). I would never show it to anyone, or, you know, go shopping or anything. The only people I've actually shown it to are the family, nobody else. I always wear gloves (P).</i></p> <p><i>In the beginning I avoided being in certain situations but not now. It took years. I remember, like, in the summer I always had long sleeves and a glove to hide it. But of course it attracts looks anyway, but you learn to live with that (P).</i></p> <p><i>It is most often children who ask what I have done. Adults just stare. My grandchild who is 5 years old hasn't said anything. She's used to it. It's just me for her. Nothing strange at all (P).</i></p>	<p><i>My appearance, couldn't be better. It's really great. I'm very proud of it (B). It's like a relief from the point of view of appearance ... that other hand that I had, that was just something to be ashamed of. I tried to keep it hidden the whole time, you know. Even without the prosthesis too. It's just that now I have no problems going into a shop or anything, with only the stump exposed and having to show it. People look. But I don't care. I would never have done that with my hand.</i></p> <p><i>Yes. ... and then it's like people often stop and ask, you make contact in a better way. A lot of people stop and ask and are interested in this (prosthetic) hand and how it works ... yes, and it's a starting point for meeting new people, new friends and such as well ... (P)</i></p>
<p><b>Body ownership</b></p> <p>The replanted hand was not experienced as part of the body in contrast to the prosthetic hand.</p> <p><i>It doesn't feel that it's part of my body. It just doesn't. It feels as if there is an alien or something sitting on it instead. (B)</i></p>	<p><i>I am proud of the prosthesis. Doesn't feel like an alien. My hand before was something to be ashamed of. The prosthesis feels more like part of me than my hand did. (P)</i></p>
<p><b>Emotional wellbeing</b></p> <p>Emotional struggles were experienced preoperatively, but postoperatively a sense of relief was expressed.</p> <p><i>I already felt it after the first year. Why did they put it there?</i></p>	<p><i>I suppose I think that I can take part in things more now actually. I feel much freer. I don't really know how to explain it properly but, it's just that my hand is no longer there. It's very liberating just not to have it. It really is, I had so much trouble with it, so that's probably why I have become a little more open, and towards other people perhaps as well. So they come to me perhaps more, so I can participate in things. It's like a relief. It's been just positive, all of it. I haven't felt any regret or doubt since the operation. Not for a second. I really haven't (P).</i></p>

ICF concepts: B: Body function; A: Activity; P: Participation.

The results from the semi-structured interview and analysed with qualitative content analysis, presented in categories preoperatively and at 1 year follow up.

(4). In addition, atrophies, and motor imbalances change the appearance of the hand. The benefits from replantation also depend on the individual coping abilities and possibility to return to daily living, work, and leisure activities (1, 26). The individual in this case described the grip function, as “non-existent.”

A hope for better grip function can be wished for, and sometimes there is too high expectations on what a prosthetic hand can provide. A hand prosthesis with limited mobility and no sensory feedback can never replace a well-functioning human hand (27, 28), and with this in mind, the very satisfying results in the case here presented are focused on improved activity and participation. Grip function in a prosthetic hand has its limits, even though it, in this case, was an advanced Bebionic hand (OttoBock). Nevertheless, hand prosthesis offered better grip function than a poorly functioning hand (5, 6, 8).

A good sensory function is vital for a useful grip function. After replantation, a substantial limited and misdirected axonal regeneration and reinnervation result in changes in afferent and efferent nerve signalling and thus adaptations in the primary somatosensory cortex and motor network in the brain. This was illustrated in the present case with close to normal touch thresholds in the replanted hand while discriminative touch was poor. This might be a result of the considerable cortical reorganisation that is a challenge for an adult person to handle in the sensory relearning (29).

Referred sensation, often following amputation, was not seen in the reported case after the planned amputation. Referred sensation is a common phantom phenomenon (30), but the cause is not fully understood, even if theories explain it by cortical reorganisation, and the neurones in the sensory cortex that were responsible for the hand prior to the amputation starts to respond to the forearm skin (31, 32). However, despite the lack of referred sensation, the discriminative touch on the forearm stump was improved. This is in line with previous results (31) and may be that the cortical area of the forearm expanded and engaged the prior hand area, and the sensibility improved.

Pain was described both before and after the amputation. With the replanted hand, the individual described the pain like tingling, stabbing, pressing or like a shooting pain inside the hand. He also experienced pain when the hand bumped against something. The NPSI questionnaire revealed diminishing pain levels at each follow-up. So did the BPI, except at the 2 years follow up, due to back pain. In the interview, the pain after the amputation is explained as something you can live with, and is not described as detailed as prior. Pain relief has previously been reported as a gain in elective arm amputations after critical soft tissue injuries (5), and in cases with brachial plexus injuries (6).

Another limiting factor that highly improved was cold intolerance. He liked outdoor activities which he could do only under limited time or not at all, depending on the pain that came with cold exposure or windy weather. Cold

intolerance is common after hand injuries and almost all adults with replantation suffer from cold intolerance (33, 34). Cold intolerance affects engagement in meaningful activities, in all areas of life, (35), as for the individual in our report. After the amputation, the cold intolerance disappeared completely, which was expressed in the interview as well as shown in CISS. This, in combination with a grip function, made it possible for the patient to resume old hobbies, like kayaking and hunting, that he had not practised for over 20 years.

The appearance of the replanted hand was a very disturbing factor. He was ashamed and hid the hand in a glove or sleeve. The appearance plays a role for the self-confidence, which also affects societal participation (10, 33). Hands are important in activities of daily life, and have a significant role in gestures, body language and communication (28), and for our perceived body image and identity (36). The value of an appealing appearance in a bionic hand in addition to some grip function is emphasised in the results in this case (37). Appearance is a part of a conscious experience of ourselves and is crucial to feel body ownership, the experience of the body being one's own (38). Even if the advanced myoelectric hand prosthesis did not have any sensory feedback system incorporated, the individual in our report expressed the experience of the prosthetic hand more as a part of the body than his own poorly functioning hand. In the proprioceptive pointing task, at the 2 years follow up the arm length was estimated closer to the actual armlength, which may indicate an improved body ownership of the prosthesis over time.

Emotional struggles were experienced preoperatively, and after the amputation a sense of relief was expressed. The individual expressed that he never had any doubts or regrets. This is also shown in the improved scores in SF-36 regarding health-related quality of life. Adjustment to prosthesis and activity restrictions has been used as a measure of emotional wellbeing, and a relationship between depression and anxiety has been reported to prosthetic adjustment and activity restrictions by extension (39). Emotional wellbeing is affected by body image anxiety, social discomfort and depression among amputees; but the individual in this case expressed an improved body image after the amputation, improved ability to perform daily activities, and was well adjusted to the prosthesis. An unsatisfactory appearance and body image can impact both emotional wellbeing and social participation in a negative way (40), and the effect is the opposite when the appearance is satisfactory.

#### *Clinical take home message*

Patients can experience unsatisfactory result following hand replantation or following major injuries in the arm rendering the hand more or less incapable of use. In such cases, the patient can wish for an amputation of the hand and subsequent fitting with a hand prosthesis, and

sometimes the wish can be built on false hopes. When an elective amputation is considered, it is of high importance to provide reasonable expectations of the outcome regarding function, grip ability, aesthetics and the risk of pain. In this case, we let the individual use a hybrid prosthetic hand before deciding on amputation, which gave an experience both regarding controlling the prosthetic hand and the grip ability. Also, appearance, body image and body ownership and how these factors influence wellbeing and social participation, should be considered in the decision-making process and in rehabilitation.

When the hand function is poor and the hand is seen as useless, especially in combination with poor sensibility, an elective amputation may be a viable option. However, it is important to keep in mind that a prosthetic hand can add functions but it can never replace a non-injured hand.

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*Ethics:* The studies involving human participants were reviewed and approved by the Swedish Ethical Review Authority in Sweden. The patient provided written informed consent to participate in this study. Ethical approval Dnr 2020-06311.

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