Efficacy of combined physical and occupational therapy treatment of patients with sub acute neuralgic amyotrophy: a proof of principle pilot-study

Master thesis

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1. Structured Abstract (264 words)

Introduction

Currently no evidence is available for a multidisciplinary intervention helping people with upper extremity complaints who are recovering from neuralgic amyotrophy (NA). These patients encounter numerous difficulties in daily life and are often not able to resume work activities. We have developed a multidisciplinary treatment program for these patients, combining physical therapy and occupational therapy. We have tried to establish a proof of principle for this treatment program

Design

Proof of principle pilot study

Methods

Eight patients recovering >6 months after NA, recruited from our outpatient clinic, have been structurally measured 3 months before and during the treatment period. All patients received eight sessions of occupational- and physical therapy over a period of 16 weeks. Including proprioceptive shoulder training, strength training, behavioral therapy and teaching of energy conservation techniques.

Results

Patients showed no significant change in patients, three months prior to entering the program. At the end of program, patients show large and statistically significant improvements ($p<0.025$) on the canadian occupational performance measure (COPM) (+2.0 points) and shoulder rating questionnaire (SRQ) (+46%) measurements. The majority of patients also show large improvements in disability of arm shoulder and hand (DASH) scores and increase of serratus anterior muscle strength (6 of 8 patients). Checklist individual strength (CIS)-fatique scores did not change significantly.

Conclusion

Results clearly show that therapy has not damaged or disadvantaged participants. They show a big improvement in efficacy in our patients. Patients learn to adapt to their complaints and limitations, are able to function better and reach higher satisfaction. Further research into a multidisciplinary approach for people recovering from NA is advised.

2. Keywords

Neuralgic amyotrophy, scapula kinesis, physical therapy, occupational therapy, self management.

3. Dutch Summary (283 words)

Inleiding

Momenteel is geen bewijs beschikbaar voor een multidisciplinaire paramedische interventie voor mensen met problemen in het functioneren van de bovenste extremiteiten na neuralgische amyotrofie (NA). Deze patiënten ervaren grote functionele problemen in het dagelijks leven. We hebben een multidisciplinair behandelprogramma, waarin fysiotherapie en ergotherapie gecombineerd worden, ontwikkeld voor mensen herstellende van NA. Het doel van deze studie is het stellen van een proof of principle voor deze behandelmethode.

Design

Proof of principle pilot studie

Methoden

Acht patienten herstellende van NA minstens zes maanden na hun aanval zijn gerecruteerd via de “plexuspoli”. Deze patiënten zijn structureel gemeten 3 maanden voor en gedurende de behandelperiode. Alle patiënten hebben acht behandelingen fysiotherapie en ergotherapie van een uur elk ondergaan, in een periode van 16 weken. De behandeling omvatte schouderblad stabiliteitstraining, krachttraining, gedragstherapie en het aanleren van energie besparende strategieën.

Resultaten

Patiënten lieten geen verschil zien in scores vanaf 3 maanden voor de behandeling tot aan het begin van de behandeling. Aan het eind van de behandeling maten we grote en statistisch significante ($P<0.025$) verschillen met de canadian occupational performance measure (COPM) (+2 punten) en de shoulder rating questionnaire (SRQ) (+46%). De meerderheid van de patiënten liet ook en grote verbetering in de disabilities of arm shoulder and hand (DASH) score zien en een vergrote kracht van de musculus serratus anterior. Checklist indivual strenght (CIS)-fatique scores verbeterden niet significant.

Conclusie

De resultaten laten duidelijk zien dat onze patiënten niet geschaad zijn tijdens de behandeling. Meetresultaten veronderstellen een grote verbetering zien in efficiëntie van onze patiënten. Patiënten lijken te leren hoe ze met fysieke en functionele beperkingen om moeten gaan, ze kunnen beter functioneren en zijn meer tevreden. Verder onderzoek naar paramedische interventies na NA wordt aangeraden.

4. List of Abbreviations

NA	Neuralgic Amyotrophy
HNA	Hereditary Neuralgic Amyotrophy
INA	Idiopathic Neuralgic Amyotrophy
NRS	Numeric Rating Scale
ADL	Activities of Daily Living
RUNMC	Radboud University Nijmegen Medical Centre
OT	Occupational Therapy
PT	Physical Therapy
MI	Motivational Interviewing
COPM	Canadian Occupational Performance Measure
DASH-DLV	Disabilities of the Arm, Shoulder and Hand – Dutch Language Version
SRQ-DLV	Shoulder Rating Questionnaire – Dutch Language Version
SBBT	Sugar, Bag and Bottle Test
HHD	Hand-held dynamometry
CIS	Checklist Individual Strength
SF-36	Short Form (36) health survey
MCID	Minimal Clinically Important Difference
VAS	Visual Analogue Scale

5. Introduction and rationale

Neuralgic Amyotrophy (NA) is a peripheral nerve disorder which affects the brachial plexus. The disease is also known as Parsonage Turner Syndrome or Brachial Plexus Neuritis[1].
NA has two distinct types: idiopathic NA (INA) and hereditary NA (HNA)[2]. INA is the most common variant with a reported incidence rate of approximately 500 new cases per year in the Netherlands [3]. However, the disorder is underrecognized and the true incidence of INA is suspected to be (much) more common [3]. The median onset for INA and HNA is in respectively the fourth- and second life's decade [3, 4]
The etiology of INA is still not fully known, but the current assumption is that the disease is caused by a combination of genetic, mechanical, auto- immune and environmental factors[2, 5]. Although there are promising results of prednisolone treatment in the acute phase of NA[6], there is no strong evidence to support any medical intervention for this disease[7].

The onset of NA usually consists of excruciating pains (numeric rating scale (NRS) 8-10) which on average last three weeks, mostly accompanied by loss of neurological function of the upper extremities and neck-shoulder girdle. In some cases the lumbar plexus is also affected, resulting in pain and loss of neurological function of the lower extremities. Sometimes the phrenic nerve is also damaged, resulting in diaphragm dysfunction [4, 8, 9]. The diagnosis NA is usually established between three and nine months after onset. This delay is expected to be mostly due to unawareness of the disorder, resulting in failure of detection of NA in primary care [8].

People with NA have long been assumed to have a very optimistic prognosis with near full recovery [10, 11]. Recent research within the Dutch NA population has shown a different perspective [3, 12]. Three years after the onset of symptoms, 61% of patients report musculoskeletal pains, 29% report therapy resistant continuous pains[3, 12]. One study found that after one year, 50% of patients are unable to work, after three years this number is still

22%. Sixty seven percent of patients report problems with household activities and 47% had difficulties with activities of daily life such as personal hygiene and grooming [13]. In a recent study of 248 patients more than 6 months after the onset of NA, only 38% of patients report no pain at all, 60% of patients reported pain in the affected shoulder during movement or lying down on it and 56% reported continuous mainly "nagging" pains. Pain has shown to cause restrictions in daily life in 54% of patients and 86% of patients experience increased fatigability of the affected arm. Forty-five percent of patients reported not being able to use a computer keyboard for more than 30 minutes [14].

The persistence of complaints even when the peripheral nervous system is recoveringis suggested to be related to the loss of motor function and movement sensation of the scapula-glenohumeral complex[13]. Patients are described as having dynamic and static instability of the scapula caused by a dysfunction of the serratus anterior, trapezius, and rhomdoid muscles[7]. These muscles are responsible for stabilizing the scapula against the chest wall during the complex scapulothoracic movement, especially during daily overhead activities requiring an anteflexion/abduction movement[15-18]. During clinical examination patients with NA also show a dysfunction of primary cervical stabilizers, myofacial triggerpoints in mainly proximal scapular musculature and neural stretching pains of mainly the brachial plexus. These physical problems combined with adaptational problems decrease NA patients' potential for functional recovery[7, 13].

Although allied health service interventions are advised, there is currently no evidence available to support such an intervention in patients recovering from NA. There are indications that standard physical therapy interventions, such as rotator cuff training or glenohumeraal mobilization techniques, are ineffective or even counterproductive in a significant proportion of the patients treated [7, 13, 14, 19].

The departments of Rehabilitation and Neurology, of the Radboud University

Nijmegen Medical Centre (RUNMC), have started a multidisciplinary outpatient clinic in 2009 called “the plexus clinic”, which serves as the national referral centre for NA in the Netherlands. In this plexus clinic patients are assessed by a neurologist, a rehabilitation physician, a physical therapist and an occupational therapist. Also an allied health treatment program has been developed for patients recovering from NA.

Patients with NA are comparable to patients with other chronic conditions because they encounter problems in adequate use of pain medication, physical functioning, participation in work and social environment and sports[14]. Thus, interventions used in chronic disease approaches might be useful in the treatment of problems experienced after NA. Functional capacity is impaired by pain, fatigue and state of decreased emotional well-being[14, 20, 21]. To improve daily functioning and reduce pain and fatigue in patients recovering from NA, they need to find balance in daily activities and their functional capacity. This may be achieved by the increase of disease knowledge, adaptation of behavior and improvement of upper extremity control. Self-management interventions have been successfully used in different chronic disease groups[22-24]. The plexus clinic treatment approach combines self-management skills with other relevant factors.

The treatment program encompasses training of body functions by improvement and adaptation of body functions such as movement and position sense of the affected shoulder girdle and improving functional endurance [19, 25-27]. The combined program also relies on teaching patients problem solving skills similar as described in the model of D’zurilla and education combined with role management skills as described by Lorig et al. [28,29]. The program combines physical therapy with occupational therapy and is supported by a rehabilitation physician.

Patients are encouraged to cope with life on a daily basis and become self-managing. We hypothesize that an increased disease knowledge, a new behavioral approach to activities

and greater control over body functions will decrease pain and fatigue. Self-efficacy is expected to improve when body functions and activities are adjusted to balance each other. It is theorized that patients who experience an increase in self-efficacy will continue using acquired skills to their benefit and therefore become self-managing[29]. This leads to a new patient adaptive treatment model (figure 1)

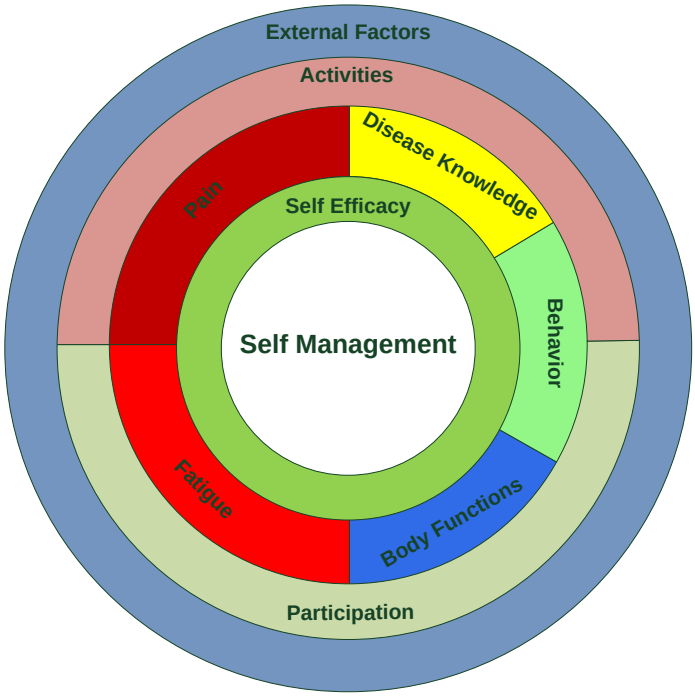

Figure 1: patient adaptive NA treatment model

The model should be used as a patient adaptive chart, the model varies with each patient and shows areas of attention in the opinion of the therapist. This can be used for patient and therapist feedback purposes. During the treatment pain and fatigue should be reduced. The occupational therapist works mainly in the outer two circles but also on improving behavior and knowledge of the disease. The physical therapist mainly works on improvement of body functions, adaptation of behavior and the conveying of knowledge about the disease.

The aim of this study was to establish a proof of principle considering the efficacy of our allied health services treatment approach in patients with sub acute NA

6. Methods

Participants

Patients were recruited by the neurologist or rehabilitation physician by convenience sample from our multidisicplinary plexus clinic based at the department of Rehabilitation of the Radboud University Medical Centre in Nijmegen (RUNMC).

Patients were included if they fullfilled the following criteria; 1) diagnosed with NA by a neurologist; 2) uni- or bilateral complaints with a NRS pain score >5; 3) recovering from subacute NA > 6 months after onset of the disease; 4) aged between 18 and 65 years; 5) understanding of Dutch written and spoken language.

Patients were excluded if they had: 1) a Beck depression inventory score >20[30]; 2) history of cerebro vascular accidents or other central neurological disease; 3) cervical radiculopathy; 4) previous surgery of the affected neck and or shoulder; 5) other neuromuscular disease.

Informed consent of each patient was obtained before the first treatment session.

Descriptive data of subjects were collected: age, sex, affected shoulder, duration of complaints before entering treatment.

Ethical considerations

This study was approved by the ethics committee of the RUNMC, with reference number: 2011/481.

Intervention

Patients were treated in eight, two-hour, sessions. These sessions were spread out over 16 weeks. The first four weeks, patients were treated weekly. Week four to eight, patients were treated once every two weeks. Week 8 to 16, patients were treated once every four weeks. After this period patients were expected to have (re-)gained the possibility for self management and the program was ended. Every treatment session consisted of one hour of

physical therapy and one hour of occupational therapy.

The physical therapy intervention addressed the training of body functions, education about the disease and its symptoms and behavioural change; see below. The occupational therapy intervention addressed behavioural change and analysis and adaptation of activities or the environment (external factors) and obtaining a balance between activities during the day or week in order to reduce the complaints. The rehabilitation physician supervised the program and supported when needed with advanced diagnostics or glenohumeraal steroid infiltration. Treatment consisted of main and optional interventions.

Main physical therapy interventions

Every patient was trained in regaining scapular muscular balance as described by Cools et. al.[26]. Further in the program, patients also received progressive resistance training of rotator cuff- muscles[31]. The rotator cuff training was carried out after the scapular muscular balance training because it was recognized that scapular stability is essential for the functioning of arm positioning muscles[32, 33]. In both interventions the focus lied on recovery of sensomotory function, and all exercises were supposed to be carried out without or with minimal pain and no or minimal pain after the exercise. The behavioural change was addressed by use of motivational interviewing techniques as described by Miller et al.[34, 35].

Optional physical therapy interventions:

Ifpatients had difficulties detecting an appropriate scapula position during exercise, and were not able to successfully implement learned scapula control movements in daily life after the second treatment session. These patients received scapular proprioceptive taping as described by Morissey and Host[36, 37].

Some patients with NAexperienced neural stretching pains of the brachial plexus.

These were likely caused by decreased space between the ribs, scapula and clavicle in the presence of a habitually protracted and adducted scapula because of serratus anterior weakness and compensatory activation of the pectoral and trapezius muscles. When present, this complication was treated by use of neural mobilisation techniques[38]. For this purpose we utilized movements designed for the "Upper Limb Tension Test"[39]. Patients were instructed to grab hold of the doorway and stretch out the arm until they experienced mild neurological sensations such as tingling or radiating pain. This stretching exercise was done three times a day with a duration of 20 to 30 seconds and repeated three times.

Patients that lacked of control of the primary cervical stabilizing muscles, tested by use of the cranio-cervical flexion test using pressure biofeedback[40], received sensomotory cervical stability training as described by Murphy et.al.[41]. Patients were treated by muscular relaxation exercises and myofacial triggerpoint releases as pre-conditioning for sensomotory scapular and cervical training. This was done when muscle tone was considered high and or trigger points were found during physical examination by the therapist[42-45].

Occupational therapy interventions

The overall goal of the occupational therapy was to help/facilitate the patient to regain control over his or her life and attain satisfaction with the achieved situation, even when residual symptoms are present. The occupational therapy program is based on the energy conservation course of Packer[46], the treatment of chronic pain patients[47] and the experiences of the plexus team within the RUNMC with the NA population. Willingness and readiness to change are essential for the therapy to be successful. Therefore Motivational Interviewing (MI) was used[48, 49]. It is important for the therapist to give the patient insight into activities that provoke pain and to teach self-management strategies to reduce (over)load and gradually increase abilities. In every therapy session a (or several) topic(s) were addressed including the implementation of minibreaks, attention for posture, communication with others, analyzing

and adapting activities or the environment and finding an balance in activities during the day and the week.

Outcome measures for physical and occpuational therapy

The outcomes for treatment efficacy were the presence and severity of functional shoulder limitations and quality of life. The Disabilities of Arm Shoulder and Hand Dutch Language Version questionnaire (DASH-DLV) was used next to the shoulder rating questionnaire (SRQ), because it is reported to be more sensitive to change and have higher reliability and validity than the SRQ[50]. The SRQ is a standard screening tool used during the plexus clinic intake and was also used in this study to control change in functional ability of patients before they entered the program. The short form 36 questionnaire (SF-36) was used to measure quality of life as perceived by the patient. The Canadian Occupational Performance Measure (COPM) is used to evaluate performance and satisfaction of the most important daily occupations that were identified by subjects as a problem. The Checklist Individual Strength 20 (CIS-20) was used to measure fatigue, the CIS-20 was also used during the plexus clinic intake and was evaluated for patient change in perceived fatigue before they entered the program. The properties of the questionnaires are described below.

DASH Dutch Language Version (DASH-DLV)

The DASH Dutch Language Version is a reliable valid and responsive measure for patients with various shoulder disorders[50-53]. It consists of 30 items, scored on a five point Likert scale, regarding shoulder, arm and hand disabilities. The items combined provide a score between 24 (no disability) and 124 (maximal disability)[53]. There are also 2 sub scores consisting of 4 items relating to functional disabilities in sports and work related activities. A minimal clinically important difference (MCID) of 10 points was found in a population with various shoulder disorders undergoing surgery[52].

Shoulder Rating Questionnaire-Dutch Language Version (SRQ –DLV)

The Shoulder Rating Questionnaire-Dutch Language Version (SRQ –DLV) is a reliable, valid and responsive measure for patients with various shoulder disorders[51, 54, 55]. It consists of a Visual Analogue Scale for global assessment of how well patients are doing with respect to their shoulder, and 19 multiple choice questions (scoring from 1 = poorest to 5 = best) for seven subscales (global assessment, pain, daily activities, recreational and athletic activities, work, satisfaction and areas of improvement). The first five subscales are graded separately by averaging the scores of the completed questions, multiplied by 2 and a weighting factor. The sum score for these subscales ranges from minimum 17 to maximum 100 points, higher scores indicating a better condition. The recommended MCID for the SRQ was set at 9% ("slightly better") or 13,5% (much better) improvement of the baseline score[56].

Short Form 36 Questionnaire (SF-36)

The SF-36 is a valid and reliable self-report questionnaire to measure general health and quality of life. The SF-36 consists of 36 questions and assesses eight health concepts: 1) limitations in physical activities because of health problems; 2) limitations in social activities because of physical or emotional problems; 3) limitations in usual role activities because of physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities because of emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions[57, 58]. The MCID of the SF-36 was reported between a 2,0 and 7,8 points difference in a population lower extremity osteoarthritis, no MCID for shoulder related complaints was found[59, 60].

Canadian Occupational Performance Measure (COPM)

The COPM is a semi-structured interview in which the patient is encouraged to identify problems in self-care, productivity and leisure activities[61]. It detects changes in the patients' self-perception of their occupational performance over time[61]. It describes activities patients cannot do, or have problems doing. The patient rates the importance of the problems on a 10-point scale from 'not important' to 'extremely important'. The five most important problems are selected and the patient is asked to rate his or her current performance of each of these activities on a 10-point scale from 'not able to do it' to 'able to do it very well'. Last, the patient is asked to rate satisfaction with the performance on a 10-point scale from 'not satisfied et all' to 'extremely satisfied'. Performance and satisfaction can be reassessed during and after a period of treatment. The average change scores of performance and satisfaction can be used as outcome measures in rehabilitation[62]. The COPM is reported to be responsive, reliable and valid[63-65]. The COPM could be used for different diagnose groups, and enables client-centered practice[65]. The MCID for the COPM was recommended to be 2 points on the satisfaction and performance subscales[61].

Checklist Individual Strength 20 (CIS-20)

The Checklist Individual Strength 20 (CIS-20) consists of 20 statements in 4 dimensions (subjective fatigue, reduction in motivation, reduction in activity and reduction in concentration) for which the person has to indicate on a 7 point scale to what extent it is applicable. The statements refer to aspects of fatigue experienced during the previous 2 weeks. A CIS total score is calculated by adding the four dimensions, ranging from 20-140. Higher scores indicate a higher degree of fatigue, more concentration problems, reduced motivation, and less activity. A total score of > 76 indicates fatigue and a score of ≥ 35 on the CIS-20 fatigue subscale indicates severe fatigue [66, 67]

Maximal isometric strength testing

Maximal isometric strength testing of flexion and extension of the elbow, glenohumeral exo- and endorotation, and the serratus anterior muscle was performed. This was done by use of a "hand held dynamometer" (the microfet2®) as protocolised by Bohannon et al.[68], with exception of the serratus anterior muscle which has been tested in the position advised in a study of Ekström et. al.[69]. Isometric strength testing of a hand held dynamometer is reported to be valid, and reasonably reliable[68, 70]. Grips strength was evaluated with a Takei® grip strength dynamometer, which has been reported to be valid and very reliable[71-73]. The reported minimally detectable difference (MDC) is 17.7 to 35.3 Newton's for these types of measurements in patients with shoulder pain and loss of function[74].

Sugar Bag and Bottle Test (SBBT)

A newly developed functional performance observation was used for the upper extremities. The test is developed to assess the capacity to perform tasks that are often problematic in patients with NA such as lifting heavy bags for a short distance and repetitively reach and lift and unscrew a bottle. The sugar bag and bottle test (SBBT) was developed at our center as a custom test for NA patients and has not yet been validated. During the test, subjects had to carry two shopping bags containing eight bags of sugar over a distance of 20 meters. ,Next, subjects were asked to place eight packs of sugar on surface levels below chest-height and overhead in a cupboard. After this, they were asked to sit down and unscrew a water bottle,for testing of functional hand strength and pro- and supination. Every performance was timed and pain experienced during and after testing was recorded by use of a 10 point numeric rating scale (NRS).

Study Timeline

Measurements were carried out at the following time points (figure two)

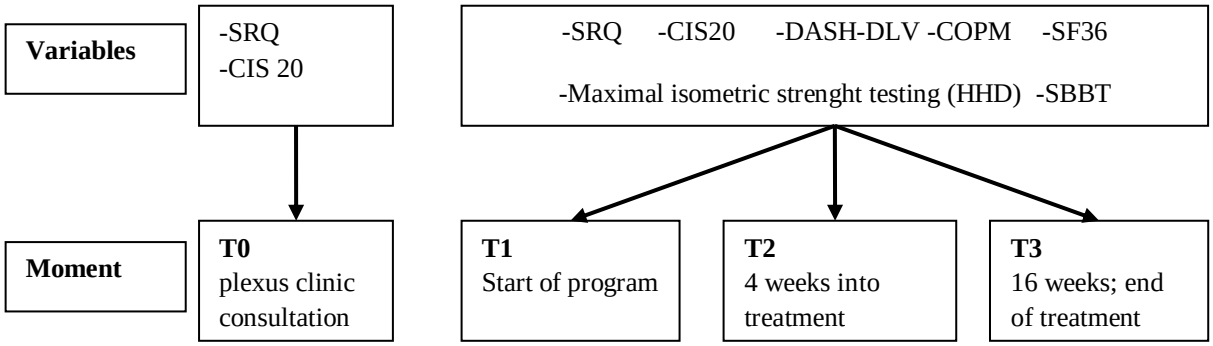

Figure 2: study procedures timeline

SRQ: shoulder rating questionnaire, CIS20: Checklist individual strength 20, DASH: disabilities of arm shoulder and hand, Dutch language version, SF-36: Short form 36, HHD: handheld dynamometry, SBBT: sugar bag and bottle test

Statistical analysis

Before entering treatment patient were measured twice during baseline to control for change in disability, pain, perception of shoulder function and fatigue. This was done by comparing the T0 questionnaires (SRQ global, SRQ Total and CIS-20) with the T1 questionnaires with use of the dependent samples T-test. Difference scores, of T0 to T3 for the SRQ and CIS-20 and T1 toT3 for the other outcomes, were controlled for normality by use of a quantile probability plot (qq-plot). Difference scores in outcomes were checked for significance by use of the paired samples T-test, significance was set at 0.05. Ninety-five percent confidence intervals were calculated. All statistical analysis were carried out with use of IBM SPSS statistics 18.0 for windows.

7. Results

An overview of the inclusion and treatment progress is shown in the flowchart (figure 3)

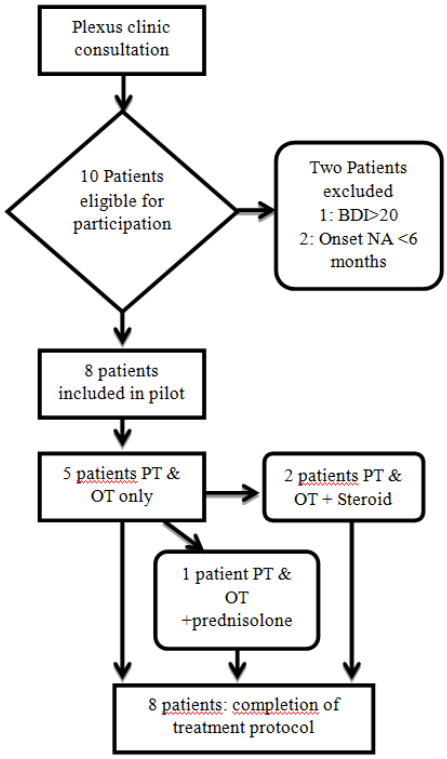

Figure 3: Inclusion and study progress flowchart

Patients

Eight patients were included in the pilot. Their mean age was 46,4 years with a standard deviation (SD) of 10.4. The mean duration of complaints until start of treatment was 34,5 months ranging from 7 to 156.

Patient characteristics at baseline are shown in table 1.

Table 1: Patient characteristics at baseline

Patient	Sex	Age in years	Time onset NA untill treatment start in months	Arm dominance	Dominant side affected?	Baseline CIS_fatigue score	Baseline SRQ total score
1	Female	34	47	Right	Yes	27	63.93
2	Male	39	156	Ambidextrous	Yes	48	51.75
3	Female	58	10	Right	Yes	42	42.42
4	Male	36	15	Right	No	51	45.45
5	Male	52	11	Right	No	39	45.82
6	Male	62	10	Right	Yes	15	44.80
7	Male	41	7	Right	Yes	43	44.50
8	Male	49	20	Right	Yes	46	50.67

NA: neuralgic amyotrophy, CIS-fatigue: Checklist individual strength fatigue subscale, SRQ total: shoulder rating questionnaire total score

All patients completed the program. Two patients developed physical therapy resistant glenohumeral capsular inflammation. They both were treated by the rehabilitation physician with a glenohumeral capsular steroid infiltration once, resulting in a reduction of inflammation and pain. One patient experienced prolonged nerve irritation of the middle plexus, including the pectoralis nerve, median and radial nerve. Which was treated with oral prednisolone. This decreased tinkling sensations and hypo sensibility and seemed to help reduce muscle tone in the pectoralis minor muscle.

Results

At baseline, no patient showed significant change in the scores of the SRQ total, SRQ global and the CIS-fatigue subscales during the 3-month period before start of the treatment program ($p>0.29$).

Seven patients improved in the COPM performance subscale, with a range of -0.3 to 3.2 points. The COPM satisfaction shows improvement shows improvement in all patients, with a maximal improvement of 4.8 points (range; 0.2-4.8). Six patients showed an improvement on the DASH total scores, with 10 points or higher with a maximal improvement of 36 points. Two patients deteriorated on this scale with a maximum of ten points. The CIS-fatigue score shows improvement in scores in six of eight patients with a range of -9.0 to 12.0.

The SRQ change scores are large. The SRQ total score showed a statistically significant improvement of 46.3 points, which is a substantial improvement of 46%, that exceeds the MCID of 13.5% for substantial improvement[56]. The SRQ total score improved in all patients with a minimum of 17.5 and a maximum of 88.7 points. The SRQ global score also showed improvement in all patients, ranging between 13.5 and 64.5 points. The SRQ pain subscale improved in all patients with 2 up to 18 points. The SF-36 social functioning scale showed an improvement up to six points in six patients while the other 2 deteriorated with a maximum of one point. The SF-36 health change subscale showed a deterioration with a maximum of three points in seven of eight patients. For the DASH score, six of eight patient showed an improvement >10 points, exceeding de MCID for the DASH [52]. These results were almost statistically significant with a drop of 11,3 points and a 95% confidence interval between 0.86 and -23.36 (P: 0.069). The COPM scores also improved in all patients, with a improvement of 1.4 points in performance and 2.3 points in satisfaction. The satisfaction subscale did not only improve significantly but also exceeded the MCID of 2 points reported for this scale[61]

The SF-36 scores did not improve significantly except for the social functioning (+1.6 points) and health change (+1.5 points) subscales.

The hand-held dynamometry measurements only show clear improvements for the serratus anterior muscle strength. Values improved for six of eight patients with a maximum of 187.5 Newton's. The SBBT total scores did not improve significantly, only two patients improved

437 with a maximum of two points. The SBBT pain scores improved in six of eight patients with a
438 maximum of 4.3 points on a 10 point scale, significance was not reached.

439 Group results for the initial and follow up measurements are shown in table 2.

440 Table 2: Measurement outcomes

Outcome	Mean Baseline	Mean end of treatment	Paired Differences*			Significance*
			Mean difference	95% confidence interval lower	95% confidence interval upper	
COPM performance	**4.5**	**5.9**	**1.4**	**0.4**	**2.4**	**.015**
COPM satisfaction	**4.3**	**6.6**	**2.3**	**0.9**	**3.7**	**.005**
DASH total	62.3	51.0	-11.3[a]	-23.3	0.9	.064
CIS-20 fatigue	38.3	36.0	-2.3[a]	-8.0	3.5	.263
SRQ total	**48.7**	**63.4**	**14.7**	**7.4**	**22.0**	**.002**
SRQ global	**5.9**	**9.3**	**3.5**	**1.9**	**5.0**	**.001**
SRQ pain	**19.5**	**26.0**	**4.0**	**2.4**	**10.6**	**.007**
SRQ adl	**12.2**	**14.6**	**2.4**	**.4**	**4.4**	**.025**
SF36 social functioning	**5.4**	**7.0**	**1.6**	**-1.1**	**3.4**	**.040**
SF36 health change	**2.0**	**3.5**	**1.5**	**0.7**	**2.3**	**.016**
Energy saving strategies	7.3	7.7	0.4	-0.5	1.4	.263
SBBT Total (seconds)	2.6	1.9	-0.7	-2.6	1.1	.365
SBBT Pain (NRS)	4.2	3.1	-1.1	-3.6	1.2	.277
Pinchgrip affected arm (N)	10.2	8.2	-2.0	-4.5	0.4	.084
Handgrip affected arm (N)	35.2	32.9	-2.3	-7.1	2.6	.313
Exorotation affected arm (N)	94.4	97.2	2.8	-21.8	27.5	.791
Endorotation affected arm (N)	108.4	116.4	8.0	-27.5	43.5	.611
Elbowflexion affected arm (N)	158.5	165.9	7.4	-34.5	49,3	.688
Serratus affected arm (N)	162.7	210.4	47.7	-15.2	110.5	.116

Elbowextension affected arm (N)	125.4	105.6	-19.8	-60.0	20.3	.260

*significance and paired statistics based on paired samples T-test
[a] Negative scores relate to functional improvement on scale
COPM; Canadian occupational performance measure, DASH; disabilities of arm shoulder and hand, Dutch language version, CIS-20; Checklist individual strength 20, SRQ; shoulder rating questionnaire, SF-36; Short form 36, SBBT; sugar bag and bottle test, (N); Strength values in Newton force, (NRS); numeric rating scale

Results for individual outcome measures are shown in figures four to seven.

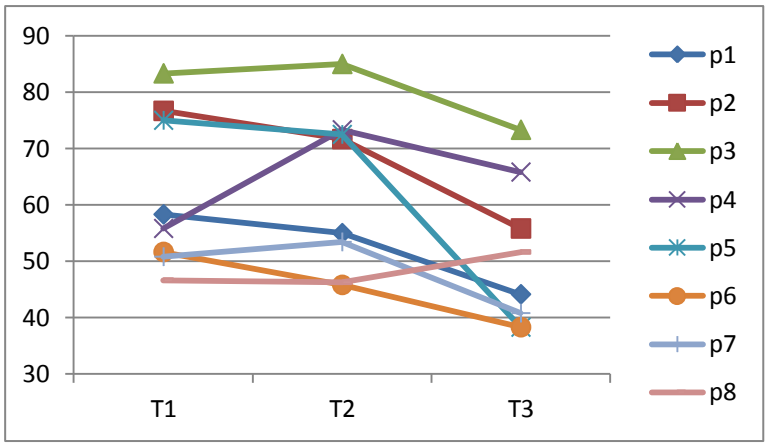

Fig 4: DASH-DLV scores
P: Patient

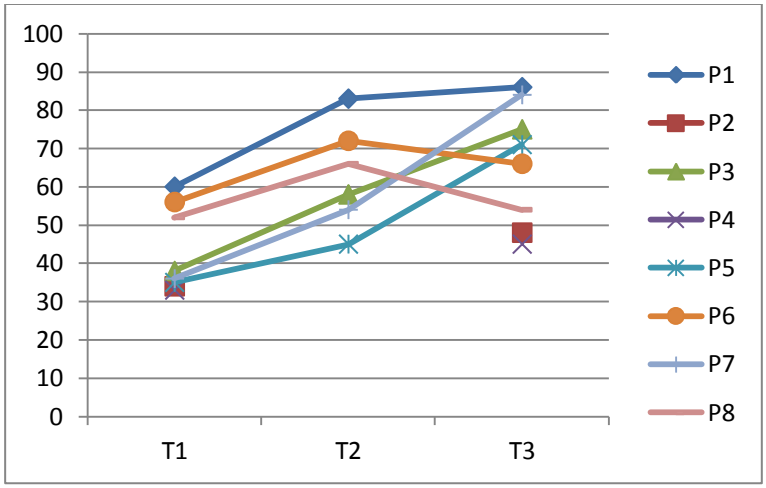

Fig 5: COPM satisfaction
P: Patient

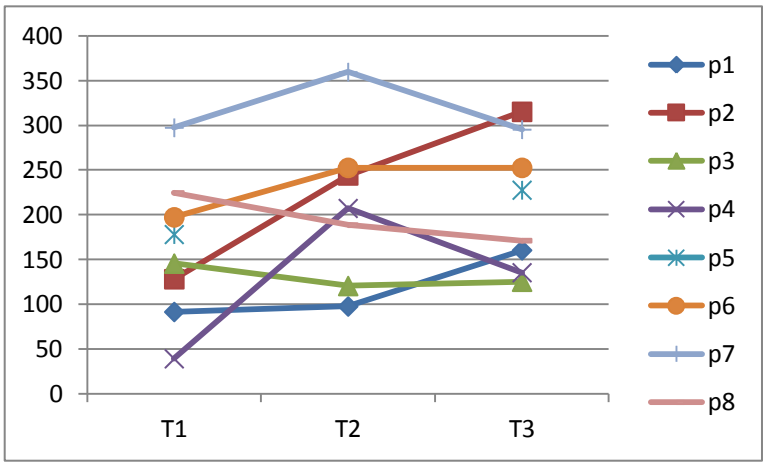

Fig 6: Serratus anterior muscle strength, affected shoulder isometric muscle strength HHD (newton force)
P: Patient

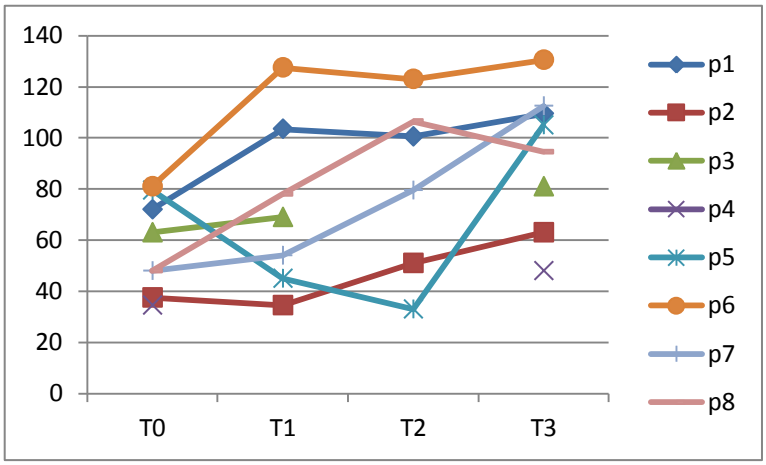

Fig 7: SRQ global perception scores
P: Patient

8. Discussion

The aim of this study was to establish a proof of principle considering the efficacy of our allied health services treatment approach in patients with sub acute NA

The vast majority of patients showed improvement in functioning, but more so in satisfaction in the COPM scores. All patients showed large improvement in the SRQ subscales, and the majority in the DASH total score. Even the lower limits of the 95% confidence interval relate to a 26.3 points and 20.4 points increase on respectively the SRQ-total and SRQ-global subscales, showing a clear clinically relevant improvement. These improvements are notable even when there was no clear change in physical strength of the affected nerves and muscles.

Strength values of the upper extremities obtained by hand-held dynamometry showed no significant change during the treatment period. Some mean changes support an increase in strength larger in number than the reported minimally detectable difference (MDC) of 17.7 to 35.3 Newton's for these types of measurements in patients with shoulder pain and loss of function[74]. However, these differences were not found statistically significant with quite broad 95% confidence intervals indicating that, although the measurements were carried out by one physical therapist, the performed measurements in our subjects might not have been very reliable. The CIS-fatigue sub scores did not improve significantly and in fact only showed improvement in two of eight patients, this shows us that there was no positive effect found on the perceived fatigue of the patients treated.

This study was designed as a proof of principle pilot study, and has its limitations. The physical measurements were carried out by the treating physical therapist and the treating occupational therapist. This was due to practical limitations in this phase of research. Another limitation is the group size, though we are enthusiastic about finding rather large and significant differences even in this small study. Two patients have received optional treatment consisting of glenohumeral steroid infiltration, sub analysis without these two subjects showed no large differences as to the whole group analysis.

Overall we feel that the observed group of patients showed us that our treatment has not harmed or negatively influenced the physical and social functioning of our patients. On the contrary, the perceived global status in the SRQ and patient satisfaction in the COPM improved quite well during the treatment period. Muscle strength did not increase significantly, which shows us that improvement in this population is primarily caused by functional and behavioral adaptation to nerve damage and corresponding loss of function of the affected shoulder. Therefore, patients' behavior in relation to complaints, smart alternative ways of carrying out (heavy) activities and acceptance of limitations appear to be the key

issues for treatment of these patients. Patients seem to learn to adapt to their limitations and achieve higher efficacy without big improvements of body functions. This is why we think a multidisciplinary intervention aimed at control of shoulder movements, adaptation of behavior and convening of knowledge provide empowering ingredients for patients to deal with their limitations.

We strongly emphasize the need for a further controlled study in a larger population to provide this multidisciplinary program with a firmer evidence base. Also qualitative studies are recommended to give better insight and understanding of the treatment ingredients that helped patients to deal with the problems as a result of NA.

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