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Research Article

In-Home Telerehabilitation for Proximal Humerus Fractures Compared to Conventional Rehabilitation: A Randomized Trial

Michel Tousignant[1,2]*, François Cabana[3], Samuel Langlois-Michaud[3], Simon Brière[1] and Catherine Pagé[1]

[1]Research Centre on Aging, Centre Intégré Universitaire de Santé et de Services Sociaux De l'Estrie - Centre Hospitalier Universitaire de Sherbrooke (CIUSSS de l'Estrie - CHUS), Sherbrooke, Quebec, Canada

[2]School of Rehabilitation, Université de Sherbrooke, Sherbrooke, Quebec, Canada

[3]Department of Surgery, Faculty of Medicine and Health Sciences, Université de Sherbrooke, Sherbrooke, Quebec, Canada

***Corresponding Author:** Michel Tousignant, Research Centre on Aging, Centre Intégré Universitaire de Santé et de Services Sociaux de l'Estrie - Centre Hospitalier Universitaire de Sherbrooke (CIUSSS de l'Estrie - CHUS), Sherbrooke and School of Rehabilitation, Université de Sherbrooke, Sherbrooke, Quebec, Canada.

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Abstract

Objective: The objective of this trial was to investigate the effect of an in-home telerehabilitation program for proximal humerus fractures compared to outpatient clinic visits.

Materials and Methods: Patients with proximal humerus fractures were recruited by an orthopedic specialist during emergency room visits. Physiotherapy treatments were given over an 8-week period using a videoconferencing system (TELE) or through face-to-face visits at the outpatient clinic (USUAL). Disabilities, including shoulder range of motion (flexion, extension, internal rotation, external rotation, abduction), and shoulder and upper limb functions were measured in face-to-face evaluations before (T1), and immediately after (T2) the program. Participant satisfaction with the healthcare services received was also evaluated at T2. Statistical analysis used the results of 30 participants.

Results: All the clinical outcomes improved post-intervention in each of the TELE and USUAL groups. Also, patient satisfaction was equivalent for both groups, showing scores of over 80% for each satisfaction factor measured. No intergroup differences were revealed in this trial for each outcome measured ($p > 0.1$).

Conclusion: Therefore, in-home teletreatment seems to be a promising way to dispense rehabilitation services for this population, similar to the effectiveness of outpatient clinical visits.

Keywords: In-Home Teletreatment; Proximal Humerus Fracture; Range Of Motion; Satisfaction; Telerehabilitation

Abbreviations

CIUSSS De l'Estrie – CHUS: Centre Intégré Universitaire De Santé Et De Services Sociaux De l'Estrie - Centre Hospitalier Universitaire De Sherbrooke; DASH: Disability Of The Arm, Shoulder And Hand Questionnaire; ROM: Range Of Motion; SD: Standard Deviation

Introduction

Humeral fractures are very prevalent [1], and can be treated surgically or conventionally with a splint or cast [2]. Regardless of the type of treatment, rehabilitation follow-up is required to prevent loss of function resulting from the fracture. In fact, physiother-

apy has been shown to be effective in improving functional status, decreasing pain and increasing shoulder range of motion (ROM) [3,4]. However, accessibility to the service presents a challenge [5], particularly in remote areas [6].

In-home teletreatment, which is an alternative to a conventional service delivery method (face-to-face), is defined as an application which uses telecommunication technologies to provide services [7,8]. Telerehabilitation is a new approach in rehabilitation allowing the patient to receive physiotherapy at home as opposed to presenting to an outpatient clinic.

In this context, we implemented a proof of concept using telerehabilitation to care for these patients [9]. This preliminary study concluded that treating humeral fracture patients with this new model of delivering services is feasible, as all clinical outcomes measured were statistically improved. Therefore, in-home teletreatment seems to be a promising way to dispense rehabilitation services to this population.

Thus, the next research step was to plan a clinical trial with a comparison group. We developed a protocol, which was registered to Clinical Trials (NCT02425267) and published in Sports Science, Medicine and Rehabilitation [10]. The purpose of this paper is to present the results of this trial.

Materials and Methods

Methods

Considering that the complete methodology has already been published [10], we will present this in an abridged form.

Design

This was a randomized controlled trial with pre-/post-tests, an experimental group (TELE) and a control group (USUAL). Participants were assessed before the in-home teletreatment program (T1 – 2-3 weeks post-fracture), and after the 8-week program (T2 – 9 weeks post-T1).

Sample

This study was conducted in the population with a proximal humours fracture treated conservatively at the Centre integer Universitario de santé et de services sociaux de l'Estrie - Centre hospitalise Universitario de Sherbrooke (CIUSSS de l'Estrie CHUS). To be included, participants had to: 1) return home after discharge from the hospital or emergency; 2) be apt to do exercises; 3) have sufficient verbal and written comprehension to participate in the treatment and evaluations; 4) have access to a high-speed Internet connection at home. Participants with the following characteristics were excluded from the study: 1) intraarticular proximal humerus fracture types (often susceptible to longer rehabilitation periods and at higher risk of complications); 2) presence of any other upper-limb fracture that could interfere with rehabilitation; and 3) surgical treatment following the fracture.

Technological infrastructure for in-home teletreatment services

Based on a modular design, a generic platform was built [11], integrating commercial systems and peripherals with custom software, TeRA. In each of the systems, a videoconferencing unit was used to provide a wide-angle pan-tilt-zoom camera, an omnidirectional microphone and an embedded codec for audio-video compression (h.264 and G711).

Independent variable: Physiotherapy program

The physiotherapy program, based on a post-prosthesis and post-fracture rehabilitation program developed by the orthopedic surgery division of the CIUSSS de l'Estrie - CHUS, includes stretching, pain management, range of motion and muscular strengthening. The training program, consisting in 30 to 45-min sessions, lasted for 8 weeks, twice daily, either supervised (TELE or USUAL) or unsupervised at home. During weeks 1, 3 and 5, patients had to perform their exercises twice under direct supervision by the physiotherapist, while other sessions were done without this supervision. For the other weeks (2, 4, 6, 7, 8), patients only had one supervised session. Supervised sessions allowed both the therapist and the patient to adjust the program if a problem occurred and assured proper execution of the exercises.

For this trial, the physiotherapy program was delivered by in-home teletreatment (TELE GROUP) or in a face-to-face meeting at the clinic (USUAL GROUP).

Dependent variables and data collection

Participants attended two evaluations with a trained research assistant at the Research Center on Aging before (T1) and after (T2) the intervention period. Each assessment was executed in the same order to optimize the validity of the collected information: 1) range of motion (flexion, extension, abduction, external and internal rotation); 2) upper limb function; 3) global shoulder function and pain; and 4) participant satisfaction. Every item was evaluated

at both assessments, except for satisfaction, which was assessed only at T2.

Description of all variables are included in the protocol paper [10].

Statistical analyses

The principal analyses intend to test the noninferiority of the TELE intervention versus the USUAL intervention. Participant characteristics in each group are described pre-intervention (T1) using mean and standard deviation (continuous variables) or proportion (categorical variables). Groups at baseline are compared using t-test or chi-squared test.

The data are analyzed according to the received intervention and the assigned group (intention to treat analysis).

Results and Discussion

Thirty-one (31) patients with non-operatively treated proximal humerus fractures were randomized in this trial. On participant was lost in follow-up and no critical events were found. The participants' characteristics are presented in table 1 and 2 No difference was revealed between the two groups.

Outcomes Mean ± SD		Tele Group (n=15)			Usual Group (n=15)			p-value*
		n	%	Mean ± SD	n	%		
Age (years)		65.5 ± 5.6			61.1 ± 12.9			0.244
Schooling (years)		12.8 ± 3.0.			12.5 ± 3.8			0.436
Height (cm)		157.4 ±12.3			163.5 ±8.7			0.162
Weight (kilos)		65.0 ± 11.5			68.7 ± 14.3			0.395
Distance between hospital and patient's home (km)		13.9 ± 8.7			15.2 ± 11.3			0.867
Time between fracture and beginning of the intervention (days)		27.87 ± 13.4			27.0 ± 12.2			0.934
Gender	Men		1	6.7		1	6.7	1.000
	Women		14	93.3		14	93.3	
Occupation	At work		5	33.3		6	40	0.396
	Retired		9	60.0		7	46.7	
	Other		1	6.7		2	13.3	
Living alone	Yes		3	20.0		4	26.7	0.671
	No		12	80.0		11	73.3	
Site of the fracture	Right		7	46.7		6	40.0	0.717
	Left		8	53.3		9	60.0	
Dominance	Right		14	93.3		13	86.7	0.550
	Left		1	6.7		2	13.3	
Fracture = Dominance?	Yes		8	53.3		4	26.7	0.143
	No		7	46.7		8	80	

Table 1: Participants' characteristics (n=31).

* The Mann-Whitney Test is used for the continuous variables and Fisher Exact Test for the categorial variables.

Outcomes	TELE GROUP (n=15)				USUAL GROUP (n=15)				Inter-groups
	T1	T2	ΔT2-T1	p-value*	T1	T2	ΔT2-T1	p-value*	p-value**
	Mean ± SD	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	Mean ± SD		
Range of motion									
Active flexion	54.5 ± 35.9	142.9 ± 23.7	92.5 ± 30.7	0.001	49.3 ± 36.7	133.8 ± 34.9	84.5 ± 36.6	0.001	0.589
Passive flexion	59.3 ± 34.9	147.7 ± 23.7	91.5 ± 29.9	0.001	54.5 ± 39.2	138.4 ± 35.6	83.9 ±36.2	0.001	0.633
Active extension	20.1 ± 8.9	35.2 ± 9.7	17.8 ± 13.9	0.001	15.5 ± 11.4	32.5 ± 6.6	17.1 ± 11.0	0.001	0.967
Passive extension	23.6 ± 9.0	38.3 ± 9.7	18.3 ±14.0	0.001	18.0 ± 12.2	35.9 ± 5.8	17.9 ± 11.3	0.001	0.917
Active internal rotation	62.7 ± 16.3	83.3 ± 9.9	18.9 ± 12.7	0.001	59.5 ± 23.6	86.1 ± 5.3	26.6 ± 24.0	0.001	0.518
Passive internal rotation	65.9 ± 15.3	85.4 ± 7.6	53.3 ± 22.2	0.001	62.7 ± 24.4	87.6 ±3.7	64.67 ± 24.5	0.001	0.105
Active external rotation	25.5 ± 17.5	52.4 ± 18.6	23.3 ± 21.7	0.001	20.5 ± 24.8	43.9 ± 26.0	23.3 ± 20.1	0.003	0.868
Passive external rotation	28.5 ± 18.1	55.5 ± 18.7	23.0 ± 22.5	0.001	22.9 ± 25.9	47.7 ± 26.3	24.1 ± 20.6	0.002	0.724
Active abduction	59.7 ± 18.6	115.6 ± 31.4	61.9 ± 32.9	0.001	49.7 ±21.6	107.3 ± 34.9	57.7 ±24.5	0.001	0.771
Passive abduction	63.3 ± 18.5	125.1 ± 30.9	61.6 ± 33.0	0.001	55.1 ± 19.8	111.7 ± 35.6	56.6 ± 25.1	0.001	0.724
Constant score									
Pain (/15)	9.5 ± 2.4	12.3 ± 2.9	2.7 ± 2.7	0.002	8.4 ± 2.8	11.6 ± 2.9	3.2 ± 3.2	0.003	0.787
Activity level (/10)	3.1 ± 1.9	7.3 ± 2.6	4.5 ± 2.5	0.001	2.5 ± 2.2	7.5 ± 2.7	5.0 ± 2.7	0.001	0.437
Reaching waist to head with the hand (/10)	3.1 ± 1.5	5.2 ± 2.5	2.4 ± 2.4	0.007	2.3 ± 1.0	4.8 ± 2.9	2.5 ± 2.6	0.004	0.966
Mobility (/40)	10.3 ± 5.7	26.9 ± 9.1	16.8 ± 7.6	0.001	8.1 ± 5.9	24.4 ± 9.0	16.3 ± 6.4	0.001	0.803
Strength (/25)	0.1 ± 0.3	7.3 ± 3.0	7.3 ± 3.0	0.001	0	6.7 ± 3.6	6.7 ± 3.6	0.001	0.554
Total score (/100)	26.2 ± 9.3	59.1 ± 17.5	33.6 ± 14.2	0.001	21.25 ± 9.5	55.0 ± 17.8	33.7 ± 12.8	0.001	0.868
Disability of the Arm, Shoulder and Hand questionnaire (DASH)									
Total score (/100)	48.2 ± 15.0	18.7 ± 16.0	-30.3 ±12.9	0.001	53.6 ± 16.3	20.2 ± 18.0	-33.4 ± 11.3	0.001	0.164
Satisfaction									
Factor 1: Relation	-	89.9 ± 7.5			-	89.2 ± 9.1			0.816
Factor 2: Service received	-	81.6 ± 10.2			-	80.3 ± 11.2			0.787
Factor 3: Organization of care	-	91.5 ± 6.7			-	87.9 ± 9.1			0.272
Total score	-	86.8 ± 8.2			-	86.1 ± 8.9			0.803

Table 2: Clinical results (fractured limb)

* Wilcoxon signed rank test;

** Mann-Whitney Test

Clinical outcomes

Shoulder ROM

The shoulder ROM results showed statistical and clinical improvements for all the movements evaluated. The pre-/post-program difference is greater than the interrater minimal clinical difference (>5 - 10 degrees) for all movements for both groups. Moreover, no difference was found between the TELE and USUAL groups.

Shoulder functional measures

Global shoulder function was measured with the Constant score, which is the primary outcome measure. This questionnaire allows the assessment of four outcomes related to shoulder function: 1) pain; 2) activities of daily living (sleep, work, leisure); 3) range of motion; and 4) muscle strength. All these subcategories showed statistical improvements. The same effect was found for the total score (ΔT2-T1 - TELE: 33.6 ± 14.2; USUAL: 33.7 ± 12.8) and no difference was found between the two groups.

Upper limb function

Function, which was evaluated with the Disability of the Arm, Shoulder and Hand questionnaire (DASH), improved in upper limb function shows (ΔT2-T1 - TELE: -30.3 ± 12.9; USUAL: -33.4 ± 11.3). This is much more significant than the minimal clinical difference (change of > 15%) (32). No difference was found between both groups.

User satisfaction with healthcare services received

The participants' overall satisfaction was very good (TELE: 86.8% ± 8.2%; USUAL: 86.1% ± 8.9%). For all sub-factors, scores obtained were over 80%. No difference was found between the two groups.

Discussion

The objective of this pilot study was to investigate the efficacy of delivering a physiotherapy program for patients with non-surgically treated proximal humerus fractures using in-home teletreatment compared to visits at an outpatient clinic. The results showed that in-home teletreatment seems to be a good service-delivery alternative compared to face-to-face interventions for this population.

This study showed statistically and clinically significant positive results in both groups for the functional outcomes measured after the program, as shown by global functional improvements in the shoulders and upper limbs.

Our results are coherent with other trials focusing on orthopedic acute conditions such as knee and hip replacements [12]. Only one other study deals with upper limb conditions [13] and our results lead to the same conclusion: There seem to be clear benefits from in-home teletreatment that gives patients access to physiotherapy at home.

Strengths of this study are based on the control of a potential selection bias. Indeed, randomization was blinded to the evaluator and participants' characteristics. As demonstrated, no strong variable potentially related to the outcome was different in the two groups. Furthermore, information bias was controlled by using standardized measures and by calibrating all the assessors for each assessment.

One of the possible challenges of in-home teletreatment may be related to the time between fracture and when the intervention was started. Indeed, a longer period of time before starting the intervention could lead to decreased functional capacities in the acute stage of recovery. We hoped to avoid delays in the installation of the in-home teletreatment platform to ensure the same time interval to start therapy in both groups. However, upon implementation of in-home teletreatment, this issue should be discussed with the Internet provider, in cases where the patient does not have access to Internet at the time of his/her fracture, to ensure that a new connection is made.

Another important point to consider in an implementation perspective is that distance from their therapist during rehabilitation should not be an issue for the patients. Indeed, satisfaction about in-home teletreatment is at least the same as in face-to-face interventions. Thus, in-home teletreatment seems to be as acceptable because sometimes it is difficult or even impossible to travel to an outpatient clinic to receive care. Staying at home and having a real-time virtual contact with a professional is an excellent alternative.

Generalization of this study should be approached with caution. Indeed, despite an equal repartition of sociodemographic variables between the two groups, we may hypothesize that patients who agreed to participate are more open to new alternative and Inter-

net/computer activities. Implementation studies should be conducted to replicate these results in a real-world setting.

Conclusion

In-home teletreatment seems to be a promising way to dispense rehabilitation services for patients with proximal humerus fractures. No practical advantage is seen for patients to travel to an outpatient clinic to receive rehabilitation services in this acute orthopedic condition. These two modes of rehabilitation service delivery should be systematically offered to patients to increase access to care.

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Conflict of Interest

The authors declare no conflict of interest.

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