Review Article

EFFECTS OF PROPRIOCEPTION IN THE REHABILITATION PROCESS OF HIP FRACTURES

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SUMMARY

This study was aimed at providing a review of the last ten years in literature addressing the effect of the physical therapeutic treatments carried out in hip fractures and the review of the description and influence of specific proprioceptive drills in rehabilitation processes. These fractures are very common, particularly among the aged population, causing various consequences to the individual, such as proprioceptive sensations changes, which can predispose patients to important joint instability. Therefore, the rehabilitation of these injuries is of great importance in order to restore hip function and to prevent recurrences. According to the literature review, studies describe physical therapeutic treatment protocols in cases of hip fractures, but most authors do not present a specific isolated proprioceptive training; they usually correlate muscular strength gain, balance and gait and functional training to an indirect improvement of joint proprioception. The shortage of theories addressing the subject is clear, and further studies are warranted for providing better clinically and statistically significant data concerning the subject in reference.

Keywords: *Proprioception; Hip fractures; Exercise; Physiotherapy.*

Citation: *Martimbianco ALC, Polachini LO, Chamlian TR, Masiero D. Effects of proprioception in the rehabilitation process of hip fractures. Acta Ortop Bras. [serial on the Internet]. 2008; 16(2):112-116. Available from URL: http://www.scielo.br/aob.*

INTRODUCTION

Proprioception is the afference given to central nervous system (SNC) by the different kinds of sensorial receptors present in a number of structures. This is the sensorial input of the muscle spindles, tendons and joints receptors to differentiate joint position and movement, including the orientation, range and speed, as well as the relative tension on tendons. Some neurophysiologists also include the vestibular receptors in the proprioceptive system, because the vestibular apparatus´ impulses provide awareness of the orientation and head movements[1]. A large number of proprioceptive receptors are found inside the muscles, such as in the muscle spindle and the Golgi tendon organ, as well as receptors located on the muscle fasciae. Ligaments, subcutaneous cell tissue and bones also have receptors, showing the great importance of this function[2]. Among key proprioceptors are the joint receptors, constituted by free ends and by Ruffini, Paccini and Golgi corpuscles, and are associated to movement position and orientation sensations, being sensitive to range and angle speed variations, as well as to intrajoint pressure. On ligaments, they act as protectors and inform the correspondent position of the limb as well as ligament tension. The receptors are stimulated by deformation, this being provided by means of traction or joint coaptation[3].

The Golgi tendon organs (GTOs) are receptors located at the muscle/ tendon and aponeurosis threshold, activated by means of tension against strong resistance (isometric contraction) and to extensive muscle stretching. Along with neuromuscular spindles, they take part of muscular tonus control and of the activation inactivation of agonist/ antagonist dynamics of the neuromotive control[3]. Spindles are regarded as the key proprioceptive sensors; they are found on skeletal muscles and are sensitive to muscle fibers´ stretching, responding both to passive and active stretching. Thus, all motion commands start from the recognition of the current status of the body (position and movement) originated by the information sent by those receptors. The proprioceptive

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Received in: 05/09/07; approved in: 09/26/07

afference gives central nervous system the ability to monitor its commands´ effects in a feedback mechanism until the movement is finished. Therefore, proprioception and the neuromuscular feedback mechanism constitute an important element to the maintenance of joint stability, initially mediated by the central nervous system[2,4]. Sensorial afference is originated from somatossensorial, visual and vestibular systems, and is received and processed by brain and spinal cord. The processing of these information results in the awareness towards position and movement, joint stabilization by reflex signs mediated by spinal cord, and balance and stance maintenance[2]. In brief, proprioception is directly correlated to joint movements and, as a result, it will be impaired if injuries occur. Fractures, for example, among other consequences, may predispose the patient to future instabilities on the affected joint[4-5]. According to Ingermasson et al.[5], after hip fractures, balance, stance control and active joint angle position are frequently shown to be damaged. Hip fractures are considered to present a high incidence rate. According to Penrod et al.[4] over 300 thousand hip fractures occur in the USA each year; 90% are related to simple falls. By 2050, the incidence of hip fractures is estimated to reach 6.3 million cases worldwide in individuals above the age of 65, mostly in post-menopausal women, usually resulting from accidental or recurrent falls. Hip fractures can be classified by anatomic region: 1- acetabular fractures, regarded as very complex, usually occur in multiple-trauma patients, and are caused by high-energy trauma; 2- femoral neck fractures, accounting for 45% of all hip fractures, lead to complications because they can impair blood inflow to the femoral head, characterizing necrosis; 3- intertrochanteric (extracapsular) fractures, occurring between the minor and the major trochanter, are also very common in the elderly; 4- subtrochanteric, which are regarded as having a lower incidence rate[6,7]. Hip fractures are very serious and, most times, surgically treated, because they are associated to very important and long-term complications[8,9]. Although measures such as prevention against falls, early osteoporosis treatment, incentive to regular practice of physical activities, as well as other diseases control, the fractures in the elderly remain quite frequent[7,10-12]. The rehabilitation process in these injuries is of great importance, and the interventions to be made should be carefully designed[13]. Usually, the primary goal of the treatment is to restore hip functions and prevent it against relapses[14-16]. Drills encompassing a progressive gain of the range of motion, muscular strengthening and functional drills, as well as proprioceptive, balance-related and postural drills, are usually introduced in a phase when bone union process is satisfactory and/ or the surgical procedure assures protection and stiffness to the injury core, and partial or total load is allowed to the affected limb. In this sense, physical therapy has shown good results, especially for prorpioception improvement, which is regarded as critical for joint stability and protection. There is a set of interventions that supplement each other to achieve significant improvements on the rehabilitation process of hip fractures and a better quality of life for the patients, providing independence in daily life activities. The purpose of the present study was to examine the effects of physical therapies employed in hip fractures by reviewing literature reports in order to observe the description and influence of proprioceptive drills in the rehabilitation process and its importance to the functional improvement of these patients.

MATERIALS AND METHODS

This was a literature review, having as inclusion criteria studies published in indexed scientific journals between 1997 and 2006 in pre-selected languages (English and Portuguese) addressing physical therapy protocols provided in hip fractures rehabilitation, including proprioceptive drills in such interventions. Articles mentioning only proprioception assessment and/ or measurement instruments that did not have enough methodological exactness allowing the study to be reproduced were excluded, as well as those addressing only data about the kind of studied population and medical interventions.

Procedures

Searches for scientific articles were made on the on-line databases *Medline, Lilacs, Cochrane and Pubmed*, using the following keywords: proprioception, hip fracture, physical therapy (technical), rehabilitation, and exercise. For selecting relevant references to the surveyed topic, simple combinations of these words have been initially employed – in English and in Portuguese – and then the research was fine tuned according to the options provided by each database for such procedure:

• *Pubmed* – the search was refined with the following limits "data de publicação" (publication date): 1997 to 2006; "humanos" (humans); "idiomas" (languages): Portuguese and English.

• *Cochrane* – a limit was determined just for publication date: 1997 to 2006.

• *Lilacs and Medline* – language: English and Portuguese; publication year: 1997 to 2006. After reading the summaries of the articles found, we selected those that met the inclusion criteria and for being identified as relevant for the development of this study. Upon selecting and assessing the reports, a chart was built evidencing study types, amounts and percentage, and; another chart, listing the author(s), year, study types, population and distribution of the groups, and the results. The selected articles basically reported aged patients, especially females, and with only one fractured lower limb. Most of the treatment protocols presented comparisons between intervention and control group(s), the latter including or not a placebo effect, or, also, using the uninjured lower limb as a control parameter. Once data were organized, these were assessed and compared, serving as a basis for discussion in this review and therapy update study.

RESULTS

Initially, sixteen studies were identified, obtained from on-line databases as an end result of keywords combinations. Six articles were included in the present study that fulfilled the inclusion criteria and were regarded as relevant for the development of this review because they described the interventions made in the rehabilitation of hip fractures, including proprioceptive drills or referring to proprioception, even if indirectly. The ten excluded articles were mostly based on the analysis of the proprioceptive sense deficit of the hip by means of evaluations with no therapeutic purposes, or without a clear description of the study methods, precluding its analysis and reproducibility (Tables 1 and 2).

Study Type	Amount of Studies	Percentage
Randomized controlled clinical study (RCCS)	3	50%
Controlled clinical study (CCS)	1	16,6%
Case Report	1	16,6%
Literature Review	1	16,6%
Total	6	100%

Table 1 – *Distribution of articles according to type (level of evidence).*

DISCUSSION

Proprioceptive deficit in an injured joint was confirmed by several studies, and may be indicative of future new injuries, consequently associated, among other factors, to the lost joint angle sense, motor and muscular damage, unbalance, gait instability, and impaired functional activities. However, it is critical to focus on proprioception drills as a complement to treatment protocols during the rehabilitation of joint conditions, including fractures[7,10,12]. However we could notice the challenges in finding articles addressing exercises protocols for hip fractures rehabilitation, with none of the included studies describing, in its physical therapeutic intervention, exercises uniquely addressed to proprioceptive gain. In general, proprioceptive improvement is indirectly related to other variables, especially gait, muscular strength and balance, since

Study Type	Author(s) / year	Population	Distribution of groups	Results
RCCS	Mangione KK et al[11] 2005	33 aged subjects (after hip fracture surgery)	Three groups: aerobic drills; endurance drills. CG: Low-intensity and short duration exercises.	There was an increase of the isometric muscle strength in the patients of both groups compared to CG, and improved aerobic power in the three groups.
RCCS	Sherrington C et al[13] 2003	81 aged subjects (after hip fracture surgery)	Strength, balance, gait, and function drills on both groups: without load discharge (A) and with load discharge (B)	Group B showed better results for balance, indirectly achieving a proprioceptive gain
RCCS	Hauer K et al[1] 2002	28 aged subjects with previous history of falls (with and without hip fracture or surgery)	Two groups: Endurance, progressive, functional, and balance-related drills. CG: memory games and activities	Increased strength and functional performance; this improvement was lost three months after drills were stopped.
CCS	Mendelsohn M, Overend TJ, Petrela RJ.[10] 2004	30 aged subjects (after hip fracture surgery).	Intervention group: strength, balance, and gait drills. CG: unaffected limb	Improvements were reported for proprioception, indirectly, on the affected limb, compared to the unaffected limb.
Case Report	Mangione, KK; Palombaro, KM.(12) 2005	Woman (68 years old); Intertrochanteric fracture (three months after surgery).	15 sessions: strength drills for LLLL, aerobic drills on stationary bicycle and functional drills. CG: unaffected limb	Increased strength on hip extensors and abductors and knee extensors Increased gait endurance, balance confidence, and ability to perform functional activities.
Literature review	Beer C, Giles E(7) 2005	Articles addressing hip fractures	Prevention, risk factors, and treatment of hip fractures.	Rehabilitation after hip fracture reduces the incidence of recurrent fractures.

Note: CG: control group; **LLLL**: lower limbs. -**RCCS**: Randomized Controlled Clinical Study; **CCS**: Controlled Clinical Study.

Table 2 – *List of the studies according to type, year/ author, population, distribution of groups, and results.*

they depend on the full integrity of proprioceptive sensations to be regarded as satisfactory and appropriate for each individual. Mendelson et al.[10] emphasized the importance of restoring joint proprioception in their study when they applied a protocol focusing isometric muscular strength and gait drills. The increased mobility, balance gains, the enhanced confidence of patients to active motion and joint angle position improvement were associated to the improvement of the proprioceptive sense, suggesting that such drills promote the stimulation of the corresponding area in central nervous system, and, as a result, the adaptation and automation of these musculoskeletal abilities. The aged population usually presents with physiological deficits on balance and stance control; reduced muscular mass, lower limbs function and locomotive capacity, factors that get worse after hip fractures and/ or surgeries, making rehabilitation to be a critical strategy, especially in terms of restoring these impaired functions. In their study, Mangione et al.[11] divided an aged population into three groups with the same prognosis, and the purpose was to assess – additionally to muscular strength – the aerobic power, with gait drills with gradual and individual times and speeds, comparing them to a control group, which performed less intense exercises. In addition to muscular strength gain in both intervention groups with respect to control, an improved performance and gait speed was found in all groups, being this fact also attributed to participants´ individual daily activities, a fact that may have influenced the results. The difference in the number of sessions performed between groups and the treatment duration was also assessed, proving the importance of a more extensive rehabilitation program for this kind of population. However, it was concluded that muscular strength significantly influences gait performance and function, since a more resistant muscle structure provides better joint stability in movements, more ambulation safety, and a resulting improvement of balance and proprioception. When we have a proper gait, we can infer that a good spatial notion of the joint position and an intact muscle structure exist. Thus, the increased muscle strength is associated, in this sense, to the improvement of proprioceptive sensations in the aged individual who suffered a hip fracture; although the study makes no reference to it, the proprioception drills combined with strengthening exercises may accelerate and add improvements to results. In a second study by Mangione and Palombaro[12], after following a similar protocol, but with more intense muscle strengthening with overload, aerobic, functional and balance-related drills, all variables have shown good results, especially the significant strength gain on hip extensor and abductor and knee extensor muscles. Such muscle groups promote joint stabilization and positioning, thus enabling proprioceptive receptors' action and favoring motion perception and balance, and subsequently, gait. Hauer et al.[1] evaluated a population with the same profile, in addition to progressive strengthening, function and balance training by means of more specific drills, such as: sitting down and standing up from chairs, climbing up and going down stairs, and keeping an orthostatic stance. We found, again, a significant muscular strength increase, an improved gait and functional performance for the intervention group, in this case emphasizing gains in balance and the subjects´ higher level of confidence regarding falls during ambulation. This evolution was particularly influenced by the specific proprioceptive training included on treatment protocol, thus proving the benefits provided by the combination of interventions. However, the gains achieved were partially lost three months after the drills were stopped, thus agreeing with Mangione et al.[11] in terms of rehabilitation program duration, because aged individuals require a longer time for tissue recovery and bone union to occur, as well as for functional readjustment and its maintenance, which suggests a home care program, targeting the recovery of the pre-fracture functional activity status, as soon as possible. On the other hand, the optimal time to start a physical therapy program in hip fractures also represents a key factor for rehabilitation process. The majority of the studies addressing this topic adopt as a criterion the partial or total load release on the affected limb, following the basic principle recommending the maintenance of stability at fracture core and the prevention against intercurrences, should bone union is not evolving appropriately. Based on the results of clinical studies reviewed here, we could notice that the research conducted by Mangione et al.[11], Mendelson et al.[10] e Hauer et al.[1] correlate the start of the physical therapy protocol to the total load release on the affected limb after surgery; however, they do not mention how long it took to release load, as well as its progression from partial to total, thus making comparisons between them and the establishment of standard for releasing load difficult. Sherrington et al.[13] assessed muscular strength, balance, gait and function of individuals allowed to place load (group A) and not allowed to place load (group B), not mentioning, again, the time length (in days) between the start of interventions for both groups. Group B performed, in bed, active hip and knee flexion and abduction exercises, isometric exercises of the quadriceps and the transfer to sedestation. Group A made a sequence of more specific drills, such as sitting down and standing up, keep stance at unipodal support; making steps towards different directions, climbing and going down stairs – together with progressive gait training. Gains were achieved for the assessed variables in both groups, but group B showed better results for balance, indirectly demonstrating an improved joint proprioception. Therefore, we concluded that the protocols described by authors are complementary to each other, apparently suggesting that early interventions, i.e., treatment started before the patient is allowed to place load, are an interesting strategy in benefiting and preparing patients to gait and to functional activities of the daily life. Drills performed with the patient at supine or sedestation position may be included in this rehabilitation phase; gait and functional drills, in a later phase. When assessing a number of studies addressing hip fractures in the elderly, Beer e

Giles[7] concluded that the prevention against such injuries is achieved particularly by mitigating risk factors for falls, including muscular strength gain, balance and gait training. As for the timing after surgery, most of the studies describe joint mobilization within the first 24 hours in order to prevent the occurrence of complications; early load release is proposed by a number of healthcare centers, depending on medical evaluation. The authors conclude that a postoperative rehabilitation program is essential in cases of hip fractures aiming to reduce the risks of new injuries and to provide higher functional independence for the elderly. It is worthy to mention the scarcity of theories in the research of the correlation between specific proprioceptive drills and hip fractures, as well as the optimal time to include these in physical therapy programs. We hope that further research is made to study the influence of proprioceptive programs in hip fractures rehabilitation protocols, achieving important clinical and statistical significance.

CONCLUSION

According to the literature reviewed, the rehabilitation process of hip fractures, especially in aged populations, presents as key interventions the muscular strength gain and gait, function and balance training. The authors correlate the good results found for these variables as an indirect improvement of the joint proprioceptive sense.

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