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Mazen Al Qahtani
Department of Physical Therapy and Health Rehabilitation, Collage of Applied Medical Science (CAMS) - Majmaah University, KSA.

Amal M. Abd El Baky
Physical Therapy Department for Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt

Intsar S. Waked
Physical Therapy Department for Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt

Walaa S. Mohammad
Department of Physical Therapy and Health Rehabilitation, Collage of Applied Medical Science (CAMS) - Majmaah University, KSA.

Correspondence:
Mazen Al Qahtani
Department of Physical Therapy and Health Rehabilitation, Collage of Applied Medical Science (CAMS) - Majmaah University, KSA.

Effect of Isokinetic Training on Burned Patient Muscle Strength: A Systematic Review

Mazen Al Qahtani, Amal M. Abd El Baky, Intsar S. Waked, Walaa S. Mohammad

Abstract
Burns that exceed 30% of the total body surface area result in marked and prolonged skeletal muscle catabolism which in turn leads to muscle weakness. This weakness persists despite 'standard'' rehabilitation programs; therefore, improvement of muscle strength is an important research area in burn rehabilitation. Various therapeutic approaches have been investigated to increase patients' muscle strength, which demonstrates that isokinetic training exercise is one of the approaches in optimally promoting muscle hypertrophy, leading to a significant increase in muscle performance. Therefore, this study was designed to review the effect of isokinetic training programs on muscle strength in burned patients. Methods: Five databases were searched between March 1990 and October 2017 for randomized and non-randomized controlled trials that investigated the effect of isokinetic exercise training on muscle strength in burned patients. The physiotherapy Evidence Database scale (PEDro) was used to evaluate the methodological quality of each study. Results: Among four articles, study results found that two papers scored 5 and 7, while the other two papers scored 8 and 9, indicating moderate and high quality, respectively. Conclusion: There is moderate to strong evidence on the effectiveness of isokinetic training exercise in improving muscle strength in severe burn patients.

Keywords: Burn, Isokinetic training exercise, Muscle strength

Introduction

In the past two decades, improvement in burn treatments and rehabilitation has contributed to better clinical results, additionally the survival rates after sever burn have significantly improved leaving survivors with numerous physical impairments [1-3]. Loss of muscle mass and strength is one of the consequences of sever burn [4]. Persistence of muscle weakness is reported in both adults and children who sustained burn injury with more than 30% of the total body surface area (TBSA) as compared to normal healthy age-matched subjects after 6 months post-burn [5-8]. These muscle weaknesses persist until 9-12 months post-burn as demonstrated for the no-exercise burned subjects [5, 7-9].

It is observed that severe burn injuries are marked by a hypermetabolic response with increased glycolysis, proteolysis, lipolysis and skeletal muscle catabolism [9,10]. As well as, increased metabolic rate can persist until wound closure is achieved [11] and perhaps for 6–9 months after wound closure [12]. Furthermore, muscle deconditioning after major burn is affected by bed rest and catabolic processes. The immobilization period after the burn may last several weeks and may lead to loss of muscle mass and strength. These changes are apparent after 2 weeks of bed rest and predominantly affect the antigravity muscles [13-15]. Moreover, recent studies found that burn has a direct impact on the mitochondrial function and gene expression of skeletal muscles in a non-burned limb [16-17]. Omar et al. [18] found a significant decrease in the amount of peak torque (PT) and total work (TW) of both quadriceps and knee flexors in burned adult patients. This finding is supported by Ebid et al. [6] who found that the PT of the knee extensors and flexors in the burned patients were significantly lower when compared with the non-burned adult. Ebid et al. [19] examined the PT of knee extensors and found a 30% decrease in the burned group vs the non-burned group. In addition, many studies reported a persistence muscular weakness in burned

patients either adult (TBSA>35%) [5, 20], or children (TBAS are 18–42%) [7, 12, 21]. Earlier studies concluded that isokinetic training programs lead to significant increase in muscle performance [6, 22]. Literatures shown that isokinetic training caused a significant increase in type II AB cross sectional area, with a reduction in type II B muscle fibers [23]. Although a number of published articles investigated the effect of isokinetic exercise training on muscle strength of burned patient, but up till now no systematic review has been conducted. Therefore, this systematic review has been conducted to evaluate the effect of isokinetic training exercises on muscle strength of sever burned patient.

Materials and methods

Literature search

The literature search was restricted to English language publications from March 1990 to October 2017. The following databases were used to find relevant studies: PubMed, Medline, CINAHL, Physiotherapy Evidence Database (PEDro), and the Cochrane Database of Systematic. In addition to the electronic searches, reference lists of all included studies and review articles relevant to the topic were checked. The references of potential papers retrieved were examined to identify any additional papers not captured through the initial search strategy. The references of identified articles were hand searched for additional relevant material. Keywords used for research were; Burn, isokinetic training exercise, muscle strength.

Inclusion criteria

Design of studies

Randomized and non-randomized controlled trials were included to evaluate the effect of different exercise interventions on muscle strength of burned adult patients.

Types of participants

Studies of both adult and children burned patients (male and female) who experienced burn injury with TBSA more than 30% were included in this review. No limits have been placed for the patients' age, site or cause of the burn injury.

Types of outcome measures

Studies which evaluated muscle strength alone or with other variables were included in this review.

Intervention

Studies demonstrated the effects of isokinetic training exercises on muscle strength of burned patient.

Exclusion criteria

Studies which involved the following issues were excluded: amputation, obesity, animals and neurological diseases.

Assessment of methodological quality

The methodological quality of each study was rated according to the PEDro scale that based on the Delphi list [24]. The scale based on 11 items that include; eligibility criteria random allocation, concealed allocation, similarity at baseline, subject blinding, therapist blinding, assessor blinding, >85% follow up for at least one key outcome, intention-to treat analysis, between-group statistical comparison for at least one key outcome and point and variability measures for at least one key outcome. Items are scored as either present (1) or absent (0) and the total score is obtained by summation. The scale reliability has been evaluated and the results showed good reliability (ICC = 0.68) among raters [25].

Data extraction and management

Studies were screened independently by the authors. After that, three reviewers separately critically assessed and scored each of the articles and presented their findings to the entire group. In case of any disagreement, the forth reviewer checked, and an agreement was achieved to reach consensus. Data related to participant demographic details, intervention characteristics, outcome assessments and results were extracted.

Results

Literature search results

Search of databases with selected keywords revealed 7 articles on the use of isokinetic training with burned patients. Three studies were excluded as they used isokinetic dynamometer for evaluation of muscle strength. The remaining four articles met the inclusion criteria and were included.

Characteristics of included studies

Four studies were included (n=214) that complied with the selection criteria and were included in this review [6, 22, 26, 27] (Table 1). Two studies [22, 27] included only pediatric burn patients, whilst two studies [6, 26] were from adult populations. All studies chose to include only patients with major burn injuries (second and third degree). The range of mean TBSA values across all included studies was 30–50.1% TBSA. Resistance training with an isokinetic dynamometer was commenced at various time points ranging from 21 days after burn injury and healing, to 6 months after the initial burn injury. The intensity of training was set at 50–60% of average torque. Training occurred two times per week for the duration of 6 weeks in Ahmed et al. [26] and three times for 12 weeks in all other studies. All exercise prescription shows in Table 1.

Effects of isokinetic training on muscle strength

Results of knee extension strength by using isokinetic dynamometry were assessed in all studies (n=214), while using the isokinetic dynamometry as exercise training was used for randomized samples in review studies (n=83). In children (n=48), there was statistically significant effect of isokinetic training on knee extension strength. Two studies (n=35) were performed with adult burns patients [6, 26]. A significant effect on quadriceps muscle strength was demonstrated in favor of isokinetic training in this subgroup, except if it is accompanied with vitamin D_3 supplement [27]. Knee flexion strength was assessed by one study [6]. There was statistically significant effect of isokinetic training on knee flexion strength in favor of the training group, however; it is less than that of knee extension strength.

Lean mass

Two studies (n=121) assessed the effect of isokinetic training on lean mass [22, 27]. One study [27] used a Dual-energy X-ray absorptiometry (DEXA) scan, whilst the other [22] calculated quadriceps size using round measurement. All assessments of lean mass were

completed in pediatric populations. Both studies showed significant effect of isokinetic training on lean mass.

Gait parameters

Gait speed was assessed in adult [6] while other gait parameters (stride length, step length, velocity and cadence) were assessed in children [22, 27]. The average ambulation speed significantly increased after isokinetic training in exercise group when compared with the baseline value and the no-exercise group [6]. In other studies, a significant increase in gait parameters in the isokinetic and control groups [22], with the largest improvement was observed when isokinetic training was accompanied with vitamin D_3 supplement [27].

Pain

No studies included in this review investigated pain as an outcome variable.

Methodology Quality

Quality assessment of the included studies according to the PEDro scale was listed in Table [2]. Criterion (1) that relates to the external validity has been retained so that this criterion will not be used to calculate the PEDro score as reported on the PEDro web site. Two reviewers IW and WM independently assessed the quality of articles. Among the four articles, two papers [26, 6] scored 5 and 7 and two papers [22, 27] scored 8 & 9 indicating moderate and high quality of rigor respectively.

Most of trials used random allocation to assign participant into intervention groups [6, 22, and 27] and these studies also used concealed allocation. In two studies [22, 27], the use of blinded assessors was explicitly described. In the remaining two studies [26, 6], none of the therapists performing the assessment for muscle strength were blinded to group assignment. Regards baseline comparability, all studies reported similarities of groups at baseline for all outcomes. All four articles had adequate described follow up due to short period of study ranged from 6 to 12 weeks. None of studies reported intention to treat analysis. All studies provided sufficient details to allow repetition of the intervention protocol and the comparisons between studies were easy. None of the studies included any indication of the percentage of reliability of the outcomes measures used.

All studies compare results with healthy non-burned subjects. All studies included individualized instructions and guidelines given to all patients before training as well verbal encouragement and visual feedback from equipment that were given in an attempt to achieve a maximal voluntary effort during all contractions that each patient was asked to performed.

Discussion

Summary of main results

This review was undertaken to investigate the effects of isokinetic training when performed in patients with a burn injury. Initial review of knee extensor strength data demonstrated that the home-based program improves extensor muscles strength when used alone during rehabilitation of children recovering from burns, however; it is insufficient to produce a long-term effect against muscle weakness. Isokinetic training demonstrated a significant effect of training on knee extensor strength in adult and pediatric burns patients. In addition, the use of vitamin D_3 in conjunction with isokinetic exercise significantly improves muscle strength. One study in adults with burn injury commenced rehabilitation prior to six months after injury, whilst in pediatric studies, rehabilitation was consistently commenced after burn injury and healing (before six months) with more training sessions. This may be explained by muscle breakdown in burn patients was observed for up to 9 months after discharge from hospital and wound healing. During this time, anabolic steroids as oxandrolone were used to increase muscle strength and body mass by decreasing muscle breakdown [7]. Hamstring strength was assessed in one adult study [6] where the overall effect was in favor of isokinetic training after a burn injury.

Improvement in gait parameters in adults and children were reported as being significantly greater after intervention for the training groups. Such improvement may be explained by the early and long rehabilitation program. Pain and safety were not utilized as outcome measures in any of the included studies. The failure to report the effect of training should be addressed in the future research as a priority. Only two studies assessed the lean mass with different assessment tools. Therefore, a variety in the outcome measures used to make comparisons between studies was difficult.

Methodological quality

The four papers included were randomized controlled trials. They provided the best evidence for treatment efficacy due to controlling of the extraneous variables and randomly assigning subjects to groups. This has maximized the equality between groups and improved the strength of the experimental design.

The methodological quality of the studies should be considered before making conclusions regarding the efficacy of isokinetic training in increasing muscle strength. Two studies were rated as moderate quality and the other two studies reported high quality. One way to improve the believability of experimental findings is to include blinding in the assessment of outcomes. This blinding will prevent the researcher from incorporating expectations about the outcome while evaluating a subject. Three studies out of four showed random concealed allocation attempts to control extraneous factors in subject pools and balances variables throughout the groups.

One of the methodological flaws, in all studies researchers did not demonstrate percentage of reliability of the data for the outcome measures chosen. Without assurance of outcome measures that yield valid and reliable data, it cannot be determined whether the treatment results are due to the treatment protocol or whether they are a result of measurement error. The combination of these factors causes concerns when considering the recommendations based on the available evidence about increasing muscle strength of burned patients by using isokinetic training

Conclusion

There is moderate to strong evidence on the effectiveness of isokinetic training exercise in improving muscle strength in severe burn patients

Table 1. Characteristics and Exercise prescription characteristics of included studies

Author	Sample size	Age (mean±SD) years	TBSA (mean ± SD) %	Study design	Intervention	Results
Ahmed et al. 2011 [26]	Burned =15 Healthy =15	Burned = 24.4 ± 3.4 Healthy=24.8 ± 2.5	30% to 40%	RCT	**Training group** **Time to begin intervention**: from 21 to 25 days after burn injury (after complete wound closure) **Location**: Clinic **Mode**: Isokinetic at 30 and 90°/s. **Duration**: 6 weeks **Intensity**: Maximum peak torque **Sessions** 12 sessions **Volume**: 3 sets/10 repetitions **Rest**: 2 min of rest between sets & 20 min rest between the2 angular velocities **Frequency**: 2 x per week **Main measures:** Muscle strength:Isokinetic muscle peak torque (PT) at 30 and 90°/s for quadriceps.	1. During eccentric contraction at angular velocities of 30°/s and 90°/s there was significant improvement in quadriceps PT in both burned (42.22, 39.38%) and healthy (27.80, 29.30%) groups. A significant difference exists between burned and healthy groups. 2. During concentric contraction at angular velocities of 30°/s and 90°/s there was significant improvement in quadriceps PT in both burned (42.22, 21.36%) and healthy (29.30, 20.22%) groups. Only a significant difference exists between burned and healthy groups at angular velocity of 30°/s.
Ebid et al. 2012 [6]	Isokinetic=20 Control=20 Healthy =***23***	Isokinetic=24.6±5.3 Control=27.3 ±8.6 Healthy=24.6±3.49	Isokinetic=46.5±3.1 Control=44.5 ±6.5 Healthy=NA	RCT	**Isokinetic group** **Time to begin intervention**: 6 months after burn **Location**: Clinic **Mode**: Isokinetic at 150°/s. **Duration**: 12 weeks (36 sessions) **Intensity**: 60% average peak torque **Sessions** 1–5: 1–5 sets, Sessions 6–24: 6 sets, Sessions 25–36: 10 sets **Volume**: 10 repetitions **Rest**: 3 min of rest between sets **Frequency**: 3 x per week **Additional**: Home exercise program **No exercise group** **Performed a prescribed home exercise program including**: range of motion exercises, stretching, splinting, massage, functional activities, and ambulation and ADL activities. **Main measures:** Muscle strength: Isokinetic concentric and eccentric torque at 150°/s for knee extensors and knee flexors Function: Gait speed assessment in metres per minute.	1. There was a significant increase in isokinetic group PT of knee extensor (21.55%) and flexor (15.48%). 2. The average ambulation speed increased in the isokinetic group when compared with the baseline value and the no-exercise group.
Ebid et al. 2014 [22]	Isokinetic=16 Control=17 Healthy=***20***	Isokinetic=13.4±1.2 Control=13.6 ±1.1 Healthy =14.2 ±1.2	Isokinetic=42.1±3.1 Control=42.4 ±3.1 Healthy=NA	RCT	**Isokinetic Group** **Time to begin intervention**: at hospital discharge **Location**: Clinic **Mode**: Isokinetic at 150°/s **Duration**: 12 weeks **Intensity**: 50% average peak torque **Sessions** 36 sessions **Volume**: 10 repetitions **Rest**: 3 min of rest between sets **Frequency**: 3 x per week **Additional exercise**: Home based program **Control Group**: Home based programincluding range of motion exercises, stretching, splinting, massage, functional activities, walking	1- There was a significant improvement in isokinetic group PT of knee extensor (68.40%) compared with the control group (9.84%). 2- There was a significant increase in quadriceps size in the isokinetic group. 3- There was a significant increase in stride length, step length, velocity and cadence in the isokinetic group and control group.

					and ADL activities. **Main measures:** Muscle strength: Isokinetic concentric PT for quadriceps at 150°/s Lean Mass: Circumferential measures of quadriceps size. Function: Gait parameters (stride length, step length, velocity and cadence).	
Ebid et al. 2017 [27]	Standard care=16 Isokinetic=17 vitamin D(VD)=15 Healthy=20	Standard care=12.9±1.3 Isokinetic= 13.1±1.5 VD=13.8±1.5 Healthy=12.8±1.6	Standard care=49.4±3.2 Isokinetic=50.1±2.1 VD=48.2±2.3 Healthy=NA	RCT	**Isokinetic group** **Time to begin intervention**: at hospital discharge **Mode**: Isokinetic at 150°/s **Duration**: 12 weeks **Intensity**: 50% average peak torque **Session**s 1–5: 1–5 sets, Sessions 6–24: 6 sets, Sessions 25–36: 10 sets **Volume**: 10 repetitions **Rest**: 3 min of rest between sets **Frequency**: 3 x per week **Duration**: 12 weeks **Additional exercise**: Home based program **VD group** **Received protocol as Isokinetic group** in addition to **Vit D_3** **Control Group**: Home based program including range of motion exercises, stretching, splinting, massage, functional activities, walking and ADL activities. **Main measures:** Muscle strength: Isokinetic concentric PT for quadriceps at 150°/s Vit D level. Lean body mass: Circumferential measures of quadriceps size. Function: Gait parameters (stride length, step length, velocity and cadence)	1- There was a significant improvement in VD group PT of quadriceps (85%) compared with the isokinetic (36%) and standard care group (12%). 2- VD levels increased significantly in the VD group (75%), but its value is still below the unburned level. The other two groups showed no significant increase in VD levels. 3- Lean body mass showed significantly increased versus baseline for the isokinetic and VD groups with the largest increased observed in the VD group. 4- In all three groups, the gait parameters increased significantly, with the largest improvement was observed in the VD group.

Table 2. Quality assessment of included studies according to the PEDro scale

Authors	**Eligibility criteria**	**Rand m allocation**	**Concealed allocation to groups**	**Baseline comparability**	**Blinded subjects**	**Blinded therapists**	**Blinded assessors**	**Adequate follow-up**	**Intention to treat analysis**	**Between-group analysis**	**Point estimates of variability**	**Total scores**
Ahmed et al. 2011 [26]	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	5
Ebid et al 2012 [6]	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	7
Ebid et al. 2014 [22]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	8
Ebid et al. 2017 [27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	9

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