

The Effect of Physiotherapy Program on Hip Pain and Postural Control in Adolescents with Sickle Cell Disease

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Abstract

Background: Sickle cell disease (SCD) is one of the most known genetic diseases in Saudi Arabia. With a common complication found to be the avascular necrosis (AVN) of the femoral head by 27% in eastern province. This avascular necrosis causes distraction of the hip joint, pain, and other complications.

Objectives: the aim of this study was to measure the effect of physiotherapy program on pain intensity and postural stability in sickle cell disease adolescents with hip avascular necrosis.

Methods: 21 participants who are aged between 10 to 18 years old and known to have Sickle cell disease with hip avascular necrosis were recruited. Measurements were taken at baseline and at the end of the treatment program. Wong-Baker FACES pain rating scale was used to evaluate the pain intensity. Biodex Balance System was used to evaluate the Overall stability index. Manual goniometer was used to evaluate the range of motion. Manual muscle testing was used to evaluate the muscle power. The statistical outcome differences within the group analysis was measured using paired t-test. Wilcoxon signed rank test was used to measure the differences within the group analysis for non-parametric variables.

Results: All participants showed significant statistical differences in pain intensity, Overall stability index at level 6, range of motion, and muscle power. However, overall stability index at level 12 post-test result was better than the pre-test result, but it did not give a significant statistical difference.

Conclusion: Physiotherapy program proved to be an effective method to improve the pain intensity and postural stability in sickle cell disease patients with hip avascular necrosis. Furthermore, improvement of range of motion and muscle power will improve or limit the related complications.

Keywords: Postural Stability, Pain, AVN, SCD, Physiotherapy

Introduction

Sickle cell disease is one of the most common genetic diseases in Saudi Arabia. The patients' red blood cells are sickling in shape due to alteration of the hemoglobin synthesis [1]. This will cause a sluggish flow of the blood in the small vessels. Subsequently, will lead to malvascularization of the body tissues and organs that causes tissue hypoxia, vaso-occlusive crisis (VOC), organ failure and severe anemia [2,3].

The main characteristic of the disease is the intermittent, unpredictable acute painful crises that end up with hospitalization [4]. In fact, the painful crisis is just the top of the pain mountain that you see in the emergency rooms. Whereas at home, the nature and the intensity of the pain represent the wide base of that mountain, which is hidden chronic pain [5]. Studies had showed that chronic pain is more

often and is underestimated [6]. It has a recognizable mode that is the condition gets worse and pain-free intervals become less while getting older [7]. The chronic pain may include bone infarction, back pain, leg ulcer, chronic osteomyelitis and avascular necrosis (AVN) of the joints [8].

The avascular necrosis starts as asymptomatic as early as seven years of age with gradual destruction of the joints. This destruction is resulted from the bone cell death due to insufficient blood circulation [9]. Several locations can be affected by the AVN such as the hip joint, shoulder joint, ribs, sternum and the vertebral bodies'. Al-Mousawi et al had found that one of the most common complications in eastern province in Saudi Arabia found to be the AVN of the femoral head by 27% which comes second to the splenomegaly complication [10]. It represents the most disabling problem to the patient [11]. Untreated asymptomatic osteonecrosis will end up with pain and collapse [12].

The results of the hip core decompression are still not optimum. A systematic review was published in Cochrane database comparing the outcomes of the surgical and non-surgical management of femoral head AVN. The result showed that the physiotherapy alone has a similar effect when compared to the result of hip core decompression combined with physiotherapy along three years follow up of 38 SCD patients [13]. Chiu et al found that balance and gait were improved two years after hip replacement in 20 subjects, but the muscle strength of the hip abductor still weak. Which confirm the need of improving the within the joint coordination by physiotherapy [14]. Also, Lenaerts G. et al had correlate the effect of hip pain that is resulted from arthritis and the subsequently the decrease in range of motion, muscle atrophy and contracture of hip flexors and adductors to the postural stability disorder and confirmed that this pain cause various degrees of postural disorders such as leg length discrepancy and pelvic obliquity [15].

Therefore, this study is aimed to find that whither the postural stability index might improve if the hip pain was managed by physiotherapy program in adolescents with SCD?

Materials and Methods

Study Design

This is a quasi-experimental study design that includes one group as pre-test and post-test to investigate the effect of physiotherapy program on pain intensity and overall stability index (OSI) in adolescents with hip pain resulted by SCD. The participants were recruited from Hematology and orthopedic surgery departments in King Fahad Military Medical Complex and Qatif Central Hospital. All participants were screened for inclusion and exclusion criteria by the researcher. The participants who met the inclusion criteria were evaluated and treated by the same researcher after signing the consent form. Evaluation was conducted at baseline, and at the end of the treatment program that is after 6 weeks by the same researcher.

Participants

Twenty five participants who are known to have SCD with hip AVN were identified as potential cases for the study. Four of the screened participants were excluded due to having one of the following reasons: having recent surgical procedure, having frequent VOC, engaged in another physiotherapy home program, or failure to commit with the experimental program. Thus, the sample of the present study end up with 21 participants from both sex. The age was ranged from 10 years to 18 years old with inclusion criteria; (a) SCD participants with hip AVN, (b) aged between 10 to 18 years old, and (c) complain of hip pain. On the other hand, any participant who had; (a) recent hip pain intervention less than 3 months, (b) recent crisis, (c) participants with stroke, or (d) participants with mental retardation or following with psychiatry were excluded from the study.



Figure 1: Participant follow the cursor on the LCD screen

Measurements were obtained at baseline and at the end of the study at Imam Abdulrahman Bin Faisal University Lab. whereas the treatment protocol was done at the physiotherapy departments either in King Fahad Military Medical Complex or Qatif Central Hospital. Participants signed the consent form after being referred by orthopedic surgeons and hematologists from both hospitals. Consent forms were obtained from the parents or guardian and ethical approval was earned from Imam Abdulrahman Bin Faisal University (IRB-PGS-2015-03-172).

Procedure

OSI

Overall stability index (OSI) was assessed using Biodex Balance System (BBS) which consists of a tilting platform to different directions. The platform gives up to 20° of tilting within 360°. The OSI score is known to be the optimum indicator for the subject's ability to maintain balance [16]. The stability platform have a range of stability levels up to level 12. Level 1 which reflects the least stable level, whereas level 12 reflects the most stable level. The participants were asked to keep upright position with opened eyes while the feet are on line with the hips with distance away from each other. The participants had to follow the cursor's movement on a LCD screen located at the level of the eyes (Figure 1). Each measurement were taken at level 12 (most stable) and level 6 (moderate stability) with 20 seconds of testing, 10 seconds rest in between to assess the OSI [17].

Wong-Baker FACES Pain Rating Scale

Pain intensity was measured by Wong-Baker FACES Pain Rating Scale that is valid and reliable measure of pain among children with SCD [18]. It consists of six faces expressions arranged from the left that indicate (0) or (no hurt), to the right that indicates (10) or (hurts worst). Each child was asked to point the face that most likely represents his pain intensity. An Arabic version of the scale was used with permission of Wong-Baker FACES scale foundation.

ROM and MP

The ROM was measured using manual goniometer [19]. The same manual goniometer was used for all participants to measure the degree of movement of affected hip joints. The same muscle groups were evaluated for MP [20]. Each participant was assessed in hip flexion, extension, abduction, adduction, internal rotation and external rotation.

Intervention

Participants had received the exercise program that consists of 12 sessions. Performed as 2 sessions per week for 6 weeks. Each session extended up to one and half hour as modified from the literature [21]. The exercises were done to the affected side only 4 during the physiotherapy sessions that include stretching, isometric and concentric exercises. While at home, the participants were asked to do active exercises to the other side. During the initial eight sessions, the participants had to do only the stretching and isometric exercises. Each exercises had to be kept for 20 seconds hold and repeated for 3 times. Rest intervals were allowed whenever needed. At the 6th session, concentric exercises were added gradually to the program by 10 repetitions, then 20 repetitions at the 7th session and 30 repetitions at the 8th session. From the 8th session till the last sessions, the concentric exercises were done as 10 repetitions for 3 sets with rest intervals in between or as needed by the participants.

Data analysis

International Business Machines (IBM) SPSS version 25 was used to analyze the data (SPSS Inc., Chicago IL, USA). Descriptive statistical analysis that include the mean (\bar{x}) and standard deviation (SD) of parametric variables were calculated. Paired t-test for within subject to measure the difference between means was used. Parametric variables include OSI and ROM. whereas for non-parametric variables, Wilcoxon signed rank test was used to analyze Wong-Baker FACES scale and MMT. Alpha level was set at 0.05.

Results

The statistical analysis were conducted for 21 participants from both sexes, 12 males and 9 females as shown in (Table 1).

OSI at Stability Level 12

The $\bar{x} \pm SD$ of OSI at stability level 12 during two leg stance on BBS of all participants were measured. Pre and post treatment were 0.867 ± 0.392 and 0.733 ± 0.329 respectively as illustrated in (Figure 2). Which indicated no significant statistical differences with $p = 0.132$.

OSI at Stability Level 6

The OSI of all participants' pre and post treatment at stability level 6 during two leg stance on the BBS was analyzed statistically by using Paired t-test. The $\bar{x} \pm SD$ were 0.919 ± 0.35 and 0.576 ± 0.26 respectively as illustrated in (Figure 2) which indicated a significant improvement after the treatment with $p = 0.001$.

Pain Intensity

Wilcoxon signs ranked test indicated that there is a statistical significant differences between pre and post treatment results in pain intensity ($Z = -4.075$, $P < 0.05$). The median score as pre and post treatment was $M = 7.00$ and $M = 2.00$ respectively as represented in (Table 2). Regarding to the previous results, there is improvement in pain intensity after physiotherapy treatment in all participants.

Table 1: Height, Weight and BMI of all Participants (n=21)

	Age (years)	Height (cm)	Weight (kg)	BMI
	21	21	21	21
X	13.19	144.3288	21.6262	28.5625
SEM	0.542	2.47028	2.33561	1.23904
SD	2.482	11.32024	10.70310	5.67799

\bar{x} = Mean SEM= Standard Error of Mean

n= Number SD = Standard Deviation

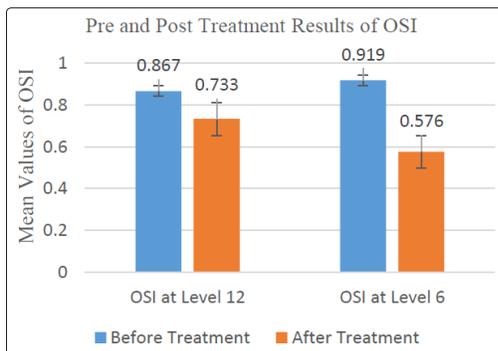


Figure 2: Pre and post treatment results of OSI of all participants

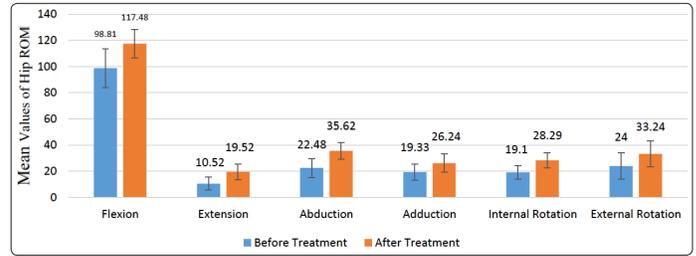


Figure 3: Pre and post treatment results of hip ROM of all participants

Table 2: Pre and Post treatment result of median values of Pain intensity

Item	n	SD	Mini.	Maxi.	50th Percentiles (M)
Pain intensity before Treatment	21	2.089	2	10	6.00
Pain Intensity After Treatment	21	1.352	0	4	0.00
Z	-4.075				
Asymp. Sig. (2-tailed)	0.001*				

n= Number SD = Standard Deviation
M= Median Z= Standard Score

ROM

The $\bar{x} \pm SD$ for hip ROM of all participants before and after treatment were presented in (Figure 3). It had indicated a statistical significant differences with $p < 0.001$.

MP

Wilcoxon signs ranked test showed that there were statistical significant differences between pre and post treatment results of MP in all muscle groups as shown on (Table 3).

Discussion

This study was aimed to investigate the effect of physiotherapy program on hip pain, postural control, ROM and MP in adolescents with SCD.

Postural Control

The results of OSI of SCD participants during two leg stance at stability level 6 had revealed significant improvement in the postural control with $p < 0.05$. This finding agrees with the results of Brech et al (Brech & Guarnieiro, 2006) who had studied the effect of physiotherapy program on 17 patients who have Legg Calve-Perthes disease.

With hip AVN. whereas in this study, the number of the treatment sessions is decreased from 24 sessions to 12 sessions along a period that extend for 6 weeks with utilizing a moderate exercise intensity on a bigger number of participants. The exercise intensity was increased gradually from session to the next session to allow the participants accommodate the new level of exercise intensity. On the other hand, the result of OSI at stability level 12 did not show any significant statistical difference which can be explained by no change in the participant's level of postural stability if he/she maintained a static position such as standing for a period of time without any external disturbance. This result of no change is considered acceptable. However, the mean result of post-treatment is better than pre-treatment result, $m = 0.733$ and $m = 0.867$ respectively,

which means it showed some improvement that could be as a result of physiotherapy program. Moreover, the reason to explain why do patients with hip AVN complain of pain in the back is because that any pathology in the hip joint will cause the patient to load unevenly on the lower limb and subsequently will lead to asymmetry of the pelvis and spine deviation [17]. The pathological process in the hip joint leads to shorten the muscles around the joint and subsequently will cause secondary contractures in the knee and ankle joints that end up with leg length discrepancy and postural disturbance. Lumbar spine will have a compensatory deviation to counteract this change in the limb length. Furthermore, this deviation of the spine will start to develop pain in the lumbar area [22]. Patients who suffer from chronic hip pain had been recorded to have weakness in the hip rotators and hip abductor muscles [23]. This chronic pain may refer not only to the back area but also to the knee joint, or to both. In contrary, if the hip muscles are trained and the strength was gained, it will improve the condition of the back and subsequently the postural control [24].

Table 3: Pre and post treatment result of median values of hip MP for all Participants

	n	SD	Mini.	Maxi.	50 th (Median)
Before Treatment MP of Hip Flexors	21	1.424	0	5	3.00
Before Treatment MP of Hip Extensors	21	1.449	0	4	2.00
Before Treatment MP of Hip Abductors	21	1.300	0	4	2.00
Before Treatment MP of Hip Adductors	21	1.461	0	4	1.00
Before Treatment MP of Hip Internal Rotators	21	1.284	1	5	3.00
Before Treatment MP of Hip External Rotators	21	1.221	0	4	3.00
After Treatment MP of Hip Flexors	21	1.030	1	5	4.00
After Treatment MP of Hip Extensors	21	1.121	1	5	4.00
After Treatment MP of Hip Abductors	21	1.236	1	5	4.00
After Treatment MP of Hip Adductors	21	1.396	1	5	3.00
After Treatment MP of Hip Internal Rotators	21	.995	1	5	4.00
After Treatment MP of Hip External Rotators	21	.928	2	5	4.00

Pain Intensity, MP and ROM

The result of pain intensity of all SCD participants for the affected hip revealed a statistically significant improvement with $p= 0.001$ and $M= 6.00$ and $M= 0.00$ respectively. These results agree with the results of a case study of a patient with SCD done utilizing aerobic and stretching exercises two times per week for 5 weeks that proved to eliminate the pain and increase the muscle strength significantly [25].

In the literatures, The most affected ROM found to be hip abduction and internal rotation in extension [26]. The treatment protocol in

this study consists of strengthening and stretching exercises for all hip muscle groups that is beneficial to restore the loss of ROM and MP caused by the recurrent pain and muscle spasm. These findings agree with Youssef et al who had studied 30 patients who suffered from femoral head AVN after the use of corticosteroid therapy as post kidney transplantation [27]. The study had used a conservative treatment program that consists of stretching and strengthening exercises combined with faradic electrical stimulation along a period of three months. The results showed significant improvement in patients' pain VAS, ROM, MP, and the functional measure timed up and down stairs (TUDS). Also, Marchese had found a correlation between pain VAS, ROM, MP and TUDS in 33 patients with acute lymphoblastic leukemia and developed femoral head AVN. He proved that while pain decreased by physiotherapy management, the ROM, MP, and TUDS are improved subsequently [28]. While on the other hand, Premkumar had observed the outcome of conventional management of femoral head AVN in 819 patients in a metaanalysis. He revealed that this management has no much effects in treating the femoral head AVN [29].

Many literatures are recommending to diagnose and evaluate the degree of the necrosis of the femoral head as early as possible to ensure the optimum treatment option and the best results whether by physiotherapy or by surgery. While some literatures had mentioned that there is no specific treatment method is indicated if the femoral head seems intact or in early stage of necrosis, other advice and prefer surgery instead of conservative and physiotherapy management if the stage was advanced with more than 80% femoral head necrosis [30-33]. Furthermore, physiotherapy is essential to improve the overall status of patient's condition with regard to pain intensity, postural stability, joint integrity and muscle performance [13].

We conclude that physiotherapy program that includes stretching, isometric and concentric exercises with frequency of two sessions per week for 6 weeks is an effective treatment method to reduce the pain and improve the OSI in SCD adolescents with hip AVN. As well as to improve the hip ROM and increase the MP.

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