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REHABILITATION OF MUSCLE DYSFUNCTION IN HEMOPHILIA

Revised Edition

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Treatment of Hemophilia Monographs
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Rehabilitation of Muscle Dysfunction in Hemophilia

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Summary

Musculoskeletal dysfunction is a common manifestation of hemophilia due to bleeding episodes. The effective management of acute hemarthroses, and hematomas in particular, is essential in order to prevent the major complications that can arise. In the longer term, the sequelae of joint and muscle bleeds, postural problems, and faulty movement patterns may be associated with imbalances between muscle groups. Evidence emerging from the literature suggests that the rehabilitation of this dysfunction is very relevant for the patient with hemophilia and musculoskeletal problems. The treatment of muscle imbalances may be linked with a reduction in recurrence of symptoms. Further research is needed to establish the relevance of this area in patients with hemophilia, but clinical experience supports the developing work in this field.

Introduction

Hemarthroses and hematomas are common manifestations of hemophilia, particularly in the severely affected individual where bleeding can occur spontaneously or follow minimal stress or trauma. Bleeding into the muscles is said to account for between 10% and 25% of all musculoskeletal bleeding episodes [1, 2].

This paper will focus primarily on two areas. Firstly, it will outline the initial physiotherapy management following common acute musculoskeletal hematomas. The second section of the paper will focus on the assessment and principles of treatment for the correction of muscle imbalances, which may follow either muscle bleeds or other muscle or joint problems that may occur in hemophilia. The rehabilitation process will be illustrated by two case studies.

Acute muscle bleeds

Bleeding can occur in both skeletal and smooth muscles [3-5]. This paper will consider only those bleeds which affect the musculoskeletal system. Common sites of bleeds include the iliopsoas, calf, thigh [6], and the forearm flexor muscles. Symptoms include pain and reduced range of movement. Stretching the affected muscle can provoke severe pain [7]. Bruising and swelling may be present [8]. For accurate diagnosis, an ultrasound (US) is an inexpensive alternative to magnetic resonance imaging (MRI) and computed tomography (CT) scans that yields good information about the size and distribution of the hematoma. It also shows whether the hematoma is solid or liquid [2].

Effective management of hematomas is essential and adequate doses of factor replacement must continue until the hematoma has completely disappeared. This must be confirmed clinically and by imaging (US, CT scan, or MRI). Discontinuing treatment too quickly may lead to rebleeding. Rebleeding is common, as muscle recovery occurs through a process of repair rather than regeneration [8]. It can lead to complications such as compartment syndromes, neurological involvement, or pseudotumours that can be catastrophic [9]. In severe hematomas, hematological treatment may need to continue for weeks or months.

Effective prophylactic programs can reduce the frequency of bleeding episodes, [10] enabling many individuals with hemophilia to be more active and engage in physical activity. As a result, sports-related injuries including muscle hematomas have been reported [11]. Mild and moderately affected patients have a reduced risk of spontaneous bleeding and are more likely to take part in vigorous activities [11].

People with hemophilia also need to be aware of the potential for direct trauma to cause muscle hematomas, which, if left untreated, may be associated with increased morbidity and even pseudotumours [12].

Prior to physiotherapeutic intervention, a full assessment must be performed to establish that physiotherapy is recommended, and to determine

baseline measurements to monitor the effectiveness of treatment [13]. Outcome assessment tools should be used to measure the effectiveness of the interventions [14]. (For a list of functional and physical examination scores suitable for use in hemophilia, consult the WFH's *Compendium of Assessment Tools*.)

Treatment of acute muscle bleeds includes rest until hemostasis has been achieved with adequate dosage of factor replacement. Thereafter, the aims of physiotherapy following an acute muscle bleed include:

- relief of pain
- return to maximal function with full range of movement
- return to maximal strength and normal length of the muscle
- prevention of recurrence

Treatment may also include guidance on appropriate active movements within pain-free limits and the use of electrotherapy modalities to hasten the resolution of the hematoma. As the bleed resolves, active mobilization, including hydrotherapy, can be initiated, progressing to gentle stretching of tight muscles as pain-free mobility permits [14]. Slow progression is recommended over vigorous treatment programs in order to prevent rebleeding into muscles [15]. Insufficient management can lead to long-term disability [9, 15].

Iliopsoas bleeds

Iliopsoas bleeds are relatively common and recovery can be slow. Signs and symptoms include flexion contracture of the hip with possible compensatory lordosis of the lumbar spine, and pain in the groin. Pain is usually less severe than hemarthroses due to the greater volumes tolerated in the muscle before compression of painful structures [16]. The pain may radiate into the iliac fossa and upper thigh, and there may be tenderness in the anterior aspect of the hip. Differential diagnosis is essential to determine whether there are other causes of pain in this region [8].

Complications of iliopsoas bleeds

Complications include femoral nerve palsy, which has been reported in 37% of iliopsoas bleeds [16], with loss of sensation in the anterior thigh, paralysis of the quadriceps muscle, and loss of patella reflex.

Signs and symptoms can take six months or more to resolve and there may be long-term disability if there has been compression of the femoral nerve. It is therefore important to prevent rebleeding by progressing with rehabilitation slowly. Complications of repeated bleeds into the iliopsoas can include pseudotumours, muscle ischemia and contractures, and neurological involvement [16]. Residual sensory loss is common. Recovery from nerve lesions may be delayed in individuals with hemophilia with inhibitors [16, 17].

Rehabilitation of iliopsoas bleeds

Treatment of iliopsoas bleeds includes adequate factor replacement and bed rest until the flexion contracture starts to resolve. It is important to maintain general mobility and strength of the upper limbs and the unaffected lower limb while on bed rest. Inner range quadriceps exercises of the affected side may also be initiated. Active mobilization, including hydrotherapy and gentle stretching in the pool, while avoiding recurrence of pain, may begin when the flexion deformity improves to 20-30°. Partial weight bearing with crutches is permitted and patients are progressed to active exercises emphasizing extension of hip and knee, i.e. glutei and quadriceps muscles and full weight bearing. All rehabilitation should be carried out under the cover of factor replacement to minimize the risk of rebleeding.

A splint may be required to stabilize the knee if the quadriceps are weak due to femoral nerve compression, prolonged bed rest, or associated knee pathology.

Rehabilitation under factor replacement cover should be continued until full extension of the hip has been achieved and there is good strength in the quadriceps and glutei muscles.

Thigh and calf bleeds

After iliopsoas bleeds, thigh and calf bleeds are the most frequent [6]. Adequate factor replacement and rehabilitation are essential to prevent long-term disability. Management principles are similar to those described earlier. Full rehabilitation of the muscle to ensure return to normal length is recommended. In the ankle, 10° dorsiflexion is required for a normal gait pattern. Associated problems of ankle arthropathy may co-exist and it is necessary to establish whether any equinus deformity is due to bony impingement as a result of talo-crural arthropathy or tight muscles. Anterior osteophytes may provide a bony restriction to range of movement [18].

Acute compartment syndrome is considered a surgical emergency requiring immediate decompression [9]. Heim et al. [19] published a case report of a child with severe hemophilia who presented with stunted foot growth and a calcaneo-equino varus deformity following the development of a compartment syndrome in the calf that was inadequately treated with replacement therapy.

Other bleeds

Bleeds into the forearm muscles can cause significant problems. The muscles lie within closed fascial compartments and the increased volume due to bleeding can lead to entrapment neuropathies, vascular insufficiency causing ischemic necrosis, and contractures [2]. Prompt and adequate factor replacement and appropriate rehabilitation are necessary to prevent long-term deformity.

Muscle Balance Rehabilitation in Hemophilia

Physiotherapy management of neuromusculoskeletal dysfunction involves the assessment and treatment of the articular system, neural system, and muscle system. Each of these systems can be affected by hemophilia, but this paper considers the muscle system only. General principles will be discussed and then related to more specific muscle problems common in hemophilia.

In a patient with hemophilia, muscle imbalance may occur as a direct result of bleeds. Habitually poor posture, predisposition to overuse injury, and insufficient flexibility may also result from hemarthroses and hematomas and these may also lead to muscle imbalance. Insufficient attention to this aspect of rehabilitation may lead to recurrence of symptoms [20].

Muscles have three important functions. They have a role in the static control of posture and alignment of joints, a role in the dynamic control and production of movement, and they also provide important proprioceptive input into the central nervous system [21]. The concept of muscle balance is that muscles provide stability and movement, but it is the balance between different muscle groups that ensures that correct joint loading and correct alignment occurs. Incorrect loading of tissue and misalignment may lead to the development of tissue pathology [21].

Muscles respond to dysfunction in one of two ways: Either by becoming overactive and tight, or by becoming inhibited and weak. This does not occur in a random fashion but frequently follows common patterns. These patterns were originally described by Janda [22].

Classification of muscles

Muscles can be classified in a number of different ways. One system is to classify muscles according to their functional characteristics. Considering these characteristics, muscles can be divided into those that have mainly stabilizing characteristics and those that have mainly mobilizing characteristics [20]. Muscles with mainly stabilizing characteristics can be sub-classified into two groups: local stabilizers and global stabilizers. Muscles with mainly mobilizing characteristics may be termed global mobilizers [21]. For muscle balance to occur, muscles with primarily stabilizing characteristics should demonstrate greater tonic recruitment (i.e. the ability to sustain relatively low force contractions for long periods of time). Muscles with mainly mobilizing characteristics should demonstrate greater phasic recruitment (i.e. the ability to generate relatively high forces, albeit briefly).

Local stabilizing muscles

Examples of the local stabilizing muscles are the deep neck flexors, multifidus, and transversus abdominis (TA), which are all concerned with the stability of the trunk [20]. These muscles tend to be small, deep, or part of a larger muscle; although the TA is not small, it is the deepest abdominal muscle. The local stabilizers are usually associated with passive joint structures such as joint capsules or ligaments. They do not usually have any significant torque-producing function but tend to have a greater endurance capacity with tonic activation during joint movements. Research indicates that these muscles tend to be activated prior to movement occurring [23-25], highlighting that their role is to stabilize the trunk and provide a stable base from which appendicular movement can occur.

The main roles of these deep local muscles are joint protection and support, and control of the ideal alignment of the spine. They provide an important proprioceptive function about where the trunk and body are in space. If there is pain for whatever reason, these muscles will become inhibited. There will be selective weakness, a decrease in force production, and a decrease in tonic holding capacity or endurance capacity of the muscle. It is possible that the lordotic

posture resulting from an iliopsoas bleed may lead to TA inhibition, as this posture is associated with tight hip flexors and weak abdominals. If left untreated, this could lead to insufficient stability within the trunk and subsequently other symptoms such as lower back pain (LBP).

There is increasing evidence that the TA and multifidus have key roles as stabilizing muscles of the trunk [20]. The TA contracts in all movements of the trunk regardless of the primary direction of movement and is recruited first in sudden movements of the trunk [24, 25]. It has been demonstrated that TA activation is delayed in patients with LBP compared to normal patients during arm movements. This delayed onset may indicate a deficit in motor control, which results in inefficient stabilization of the spine [25]. There is also evidence that the multifidus is segmentally inhibited within 24 hours following the first episode of acute LBP and that recovery of the multifidus is not spontaneous when LBP has resolved [26, 27].

The clinical implication is that the patient with hemophilia and musculoskeletal pathology affecting the spine or peripheral joints may have poor trunk control. Therefore, assessment of stability in the trunk is important and, where necessary, treatment must be considered.

Global stabilizing muscles
Global stabilizers such as the lower and mid-trapezius and gluteal muscles are not only stabilizers but they also produce torque. They tend to produce movement in one plane only, have an important role in controlling antigravity positions, and are primarily involved in slow, controlled eccentric movements and the deceleration of joint movements. Dysfunction in these muscles due to pain leads to inhibition of the muscle with delayed activation. These muscles are lengthened and test weak in inner range positions. The activation threshold of these muscles increases, so it becomes more difficult to recruit tonic fibres. However more phasic fibres, which fatigue quickly, are recruited.

Changes in muscle function have been identified in the activation patterns in the gluteal muscles following a sprained ankle [28]. Interestingly this occurred on both the affected and unaffected sides, suggesting that there was a delay in motor control [28]. It could be hypothesized that a similar abnormal pattern of muscle activity could occur in a patient with hemophilia with ankle arthropathy.

Patients who have experienced bleeds around the shoulder may present with pain and anterior translation of the humeral head, often associated with poor scapular control. Rehabilitation programs to regain appropriate activation of the rotator cuff [29] and scapular stability [30] are important considerations in these patients.

Global mobilizing muscles
Gastrocnemius and hamstrings are examples of global mobilizers. These muscles are mainly torque producers—they tend to be located more superficially than local stabilizers, and they are not linked directly to joints. They usually have fusiform, long fibres that are required for increased load and speed, i.e. when greater muscular forces are needed. These muscles may have a tertiary stabilizing role.

Pain due to dysfunction in the musculoskeletal system may cause these muscles to go into spasm [21]. For example, during an acute bleed the muscle will be held in a shortened position. Also in the presence of sensitized neural tissue or inappropriate movement patterns, these muscles may become overactive and develop an increased stabilizing role not being provided by the stability muscles. The overactive muscles are inappropriately recruited and their low threshold activity predominates, so more tonic fibres, which have an increased resistance to fatigue, are recruited. These muscles assume an antigravity postural function. As the muscles become overactive, short, and dominant, joint alignment can be affected, with resultant pathology [21].

Assessment and principles of treatment of muscle imbalance

As the stabilizing and mobilizing muscles have different functional characteristics, they must be assessed and treated differently. The stabilizing muscles are assessed by their ability to activate and hold in inner range [20, 31], while muscle length tests [32] are more appropriate for determining dysfunction in mobilizing muscles.

A progressive program of muscle rehabilitation has been described by Comerford and Mottram [21]. This program includes:

1. Control of the stability of the muscle in neutral positions
2. Regaining dynamic control in the direction of symptom-producing movements
3. Rehabilitation of the global stabilizing muscles through range
4. Lengthening of global mobilizers
5. Integration into normal function

The initial stages of the program focus on low load, low effort, and isolated activation of muscles in pain-free positions, which can be ideal for patients with marked joint pathology.

When treating the local stabilizing muscles, it is important to focus on the appropriate activation of the affected muscle in isolation from the mobilizing muscles. Facilitation strategies such as tactile facilitation or working the muscle with another stability muscle may be used [33].

It is important to activate these muscles in the absence of pain; otherwise the muscle will remain inhibited. Once activated, focus must remain on the endurance capacity by increasing the holding time and avoiding substitution from other muscles. It is also important not to work to fatigue because this too will cause these muscles to become inhibited.

Once the correct activation pattern has been established, exercises should be repeated frequently and incorporated into functional activities. It may not be appropriate to progress to high load activities when rehabilitating people with hemophilia [34]. Fast ballistic exercises are not indicated because they can inhibit stabilizing muscles.

The classic muscle test positions of inner range holds are used for the global stabilizers, again progressing by increasing the holding time [32]. It is important to avoid fatigue. Once activated, exercises should be incorporated into functional activities and repeated frequently.

When imbalances are present between muscle groups, the stability muscles are activated prior to lengthening the overactive short muscles. If the mobilizing muscles are just hypertonic, they will relax by reciprocal inhibition. If they are adaptively shortened, then it is necessary to add lengthening techniques for the tight muscles. The trunk, cervical spine, scapula, and pelvis should provide a stable base from which functional movement can occur. Clinically poor stability of the trunk is often associated with tightness of more peripheral muscles such as hamstrings or gastrocnemius as the body strives to achieve stability.

Case History 1

A 46-year-old patient with factor IX deficiency (< 1%) presented with left anterior knee pain and a feeling of weakness of the joint, but no "giving way" sensation. Symptoms had started 6 months earlier for no apparent reason, but were worsening. Pain was aggravated by getting in or out of a car, standing from a sitting position, and travelling up and down stairs. The patient had had no recent bleeds into the left knee but had had occasional bleeds in the past.

The patient's previous medical history included an arthrodesis of the right knee when he was 26 years old. He complained of intermittent bleeds into both ankles.

Examination

On examination, the right leg was 2.5 cm shorter than the left and the patient tended to compensate for this by standing with his left leg abducted. He had a range of motion (ROM) of 20-120^{o} of knee flexion. Passive knee flexion movement was associated with patellofemoral crepitus and pain. A small effusion was present. The quadriceps muscle was weak, especially the vastus medialis obliquus (VMO), and the iliotibial band was tight. There was weakness of the stabilizing muscles of the trunk and pelvis. Assessment of the patellar position [35] identified that it was sitting more laterally than normal and was tilted laterally.

A plain anterior-posterior (A-P) radiograph showed minor degenerative changes of the tibiofemoral joint.

The clinical impression was that this was a left patellofemoral dysfunction secondary to the fixed flexion deformity and tight lateral structures.

Management

All physiotherapy was undertaken under factor replacement cover.

Management consisted of passive mobilization of the tibiofemoral joint to increase range of extension. The patella was passively mobilized to lengthen the tight lateral structures. Tape was applied to provide a sustained stretch to the tight lateral structures as well as facilitate contraction of the VMO.

The stabilizing muscles, the VMO, and the posterior fibres of the gluteus medius were re-educated by focusing on sustained low-intensity contractions. Trunk stabilization work to improve the function of the deep abdominal muscles was included. The normal positions used for these initial exercises (i.e. four-point kneeling) were modified because of the patient's arthrodesis. Exercises were progressed into functional positions and gait was re-educated.

The patient had 12 sessions of physiotherapy and made good progress with significant relief of pain. There was no sensation of weakness, although intermittent swelling of the knee did persist following prolonged weight-bearing activities. ROM improved to 10-120º of flexion with a bony end feel on extension.

Summary
The anterior knee pain may have developed due to overuse of the left knee as a result of the longstanding arthrodesis on the right side. The shortness of the right leg was compensated for by abducting the left leg and flexing the knee. The patient had adapted to this position and did not wish to consider a heel raise. The weak stabilizing muscles were re-educated along with lengthening of the tight structures. The patient was discharged with advice on how to initiate a home program.

Case History 2

A 19-year-old male student with factor IX deficiency (2-5%) presented with right hip pain that radiated intermittently to his groin and upper thigh. Pain was aggravated by standing, kicking a football, and walking—especially on an incline. He also complained of a feeling of "giving way", a general feeling of leg weakness, and intermittent LBP. Symptoms had been present for over a year but had been worsening over the last three months with an associated loss of function. He had a tendency to overdo activities and found the increase in pain frustrating. He had experienced no recent bleeds into the right hip.

Previous history included Perthes disease of the right hip, which had resulted in surgery. He had had recurrent right hip and iliopsoas bleeds since removal of the metalwork 18 months prior. Other joint bleeds were rare until recently, when there had been an increase in the frequency of bleeds in his knees and right elbow.

Examination
On examination, the right leg was 2 cm shorter than the left. Right hip movements were limited in all ranges, particularly extension and medial rotation. Weight bearing was reduced on the right side, and the right hip was held in external rotation. Gluteal and quadriceps muscle wasting and weakness were present, and there was tightness in the iliotibial band, hamstrings, and iliopsoas. Knee movements were full. The patient had an increased lordosis and scoliosis at the thoracolumbar junction and limited lumbar flexion. There was poor trunk stability and no neurological deficit. X-rays of the right hip demonstrated moderate degenerative changes.

The clinical impression was that there was right hip dysfunction and pain due to the underlying pathology, and this was associated with trunk and muscle imbalances.

Management
Treatment included passive mobilization to the right hip joint to increase extension and medial rotation. Trunk stability training was undertaken, focusing on the TA and multifidus. A progressive exercise program to strengthen gluteal and quadriceps muscles included closed kinetic chain exercises to aid tonic recruitment and improve proprioceptive afferent input. Exercises to lengthen the iliopsoas, the hamstring, and the iliotibial band were added and posture was re-educated. The patient was also given a home exercise program.

The patient received 10 sessions of physiotherapy. The main outcomes were a marked relief of hip pain, cessation of back pain, improved range of movement at the hip and lumbar spine, an increase in muscle strength, an improvement in posture (as evidenced by reduction in lumbar lordosis and scoliosis), and no sensation of hip weakness or giving way. The patient was able to walk and stand for longer periods and he reported a reduction in bleeds.

Summary
This patient's hip pain was due to underlying hip pathology, exacerbated by associated muscle imbalances in the trunk and hip region. Re-education of trunk stability was undertaken prior to the progressive strengthening and exercises to lengthen the affected muscles. This was to ensure that the trunk was sufficiently stable to allow the subsequent exercises to be performed safely and effectively. Accordingly, the patient's symptoms were not exacerbated during the treatment program.

Conclusion

Musculoskeletal dysfunction is a common manifestation of severe hemophilia, typically resulting from hemarthroses and muscle hematomas. Common sites of muscle bleeds include the iliopsoas, thigh, calf, and forearm flexors. The advent of

prophylactic replacement therapy has enabled even severely affected patients to participate in physical activity and therefore all patients may sustain sports-related injuries, including direct injuries to muscle, as well as spontaneous bleeds. Patients need to be aware of the significance of such injuries and seek prompt treatment that should be continued until the bleed has resolved.

Habitually poor posture, repetitive activities, or insufficient rehabilitation may lead to an imbalance between different muscle groups. Appropriate management is essential to prevent long-term disability. The principles of rehabilitation following acute muscle bleeds have been outlined, together with general principles for the management of muscle imbalances. Specific management of musculoskeletal dysfunction should be undertaken in conjunction with advice on appropriate general exercises, sports, and lifestyle. These are all important considerations in the management of individuals with hemophilia.

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