Rehabilitation After Surgery of the Spinal Deformity

Deformite Cerrahisi Sonrası Rehabilitasyon

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ABSTRACT

The main aim of the rehabilitation programs following surgical correction of spinal deformities is to restore the patient to full function as early as possible without compromising the integrity of the surgical intervention. The most important issue that need to be considered includes avoiding stress on the healing spine by avoiding strengthening exercises or range-of-motion exercises in regions that will apply significant forces to the healing spine. Early mobilization after surgery is important to prevent deconditioning and other secondary postoperative morbidities. The main points of the rehabilitation program include patient education, teaching spine protection principles and avoiding excessive stress on the healing spine. The rehabilitation plan should be based on basic sciences. Osseointegration and tissue healing timelines are important determinants of the rehabilitation program that should be taken into consideration. Core stabilization exercises strengthen the deep muscles of the spine and helps energy transfer of the body. Whole kinetic chain exercises like walking, swimming in addition to core stabilization programs are important parts of the rehabilitation programs. Close communication between surgeon and the rehabilitation team is crucially important during the return of the patient to normal daily activities.

KEYWORDS: Rehabilitation, Scoliosis, Spinal deformity, Core stabilization

ÖZ

Deformite cerrahisi sonrası rehabilitasyon programının amacı hastayı mümkün olan en kısa zamanda tam fonksiyonel duruma ulaştırmaktır. Bu noktada en önemli mesele, yapılan cerrahi girişimi riske atmadan eklem hareket açıklığı ve kuvvetlendirici egzersiz programlarının planlanmasıdır. Cerrahi sonrası kondüsyon kaybını ve diğer sekonder morbiditeleri önlemek için erken mobilizasyon önemlidir. Rehabilitasyon programı açısından özellikle üzerinde durulması gereken konular, hasta eğitiminin yapılması, omurga koruma prensiplerinin öğretilmesi ve cerrahi sonrası iyileşmekte olan omurgaya aşırı yük bindirecek egzersizlerden kaçınmaktır. Rehabilitasyon planı mutlaka bazı temel bilimlerin üzerine oturtulmadır. Osteoentegrasyon-implantın kemikle bütünleşme-süreci, cerrahi sonrasında egzersizlerin ilerleme hızının da belirleyicisidir. Osteoentegrasyon süreci göz önüne alınmalı, doku iyileşmesinin zaman aralıkları rehabilitasyon uzmanı tarafından iyi bilinmelidir. Core stabilizasyon egzersizleri, omurgayı stabilize eden derin kasları kuvvetlendirir ve vücudun enerji transferine katkıda bulunur Core stabilizasyon egzersizleri ile beraber kinetik zincirin bütününü çalıştıran yürüyüş, yüzme gibi aktiviteler deformite cerrahisi rehabilitasyon programlarının önemli parçalarıdır. Hastanın normal günlük yaşama dönüşü sürecinde cerrah ve rehabilitasyon ekibi arasındaki sürekli iletişim son derece önemlidir.

ANAHTAR SÖZCÜKLER: Rehabilitasyon, Skolyoz, Omurga deformitesi, Core stabilizasyon

INTRODUCTION

While planning rehabilitation following surgical correction of spinal deformities, the aim is to ensure full functioning of the patient as early as possible. However, the most important issue that needs to be considered is to plan the exercise programs without compromising the surgical intervention. Scoliosis including shape and position changes of the spine, trunk and thorax together is defined as the three-dimensional torsional deformity of the spine. It causes lateral curvatures in the frontal plane and also axial rotations in the horizontal plane. Moreover, it affects normal curvatures of the kyphosis and lordosis in the sagittal plane and may change them in the direction of a flat-back. (8).

There are different etiologies, treatment approaches and outcomes of idiopathic (infantile, juvenile, adolescent), congenital and neuromuscular scoliosis. Rehabilitation programs following surgical correction of spinal deformities play an important role in the progress of treatment. It is necessary to apply appropriate exercising programs for different clinical scenarios due to complex anatomy and biomechanics of the joints and soft tissues forming the spine.

At the beginning of this article, congenital, neuromuscular and idiopathic scoliosis is generally mentioned with regard to the progress of the rehabilitation. Then, the paper explains which basic sciences the rehabilitation program following the most frequently seen idiopathic scoliosis should be based on. Osseointegration, incorporation of implant into the bone, is a determinant for the progress rate of exercises following the surgery. Core stabilization exercises strengthen the deep muscles of the spine and contribute to the load transfer of the body. An important point to be considered in spinal problems is teaching the activities that can lead to pain and also the spine protection principles to the patient and family. And finally, some examples of the phases of rehabilitation program and exercises are given.

MAIN POINTS of CONGENITAL, NEUROMUSCULAR and IDIOPATHIC SCOLIOSIS with REGARD to the PROGRESS of REHABILITATION

Congenital scoliosis is a three-dimensional progressive deformity that develops depending on the congenital anomalies in the vertebras and it causes imbalance in the longitudinal growth of the spine. Surgery should be performed as early and practically as possible in order to be able to prevent secondary structural changes. All patients with congenital scoliosis should be evaluated in terms of genitourinary anomalies. Fusion surgery is delayed for skeletal maturation in idiopathic scoliosis while early deformity surgery is desired for preventing possible structural spinal decompensations in congenital scoliosis and the least number of vertebra fusions is aimed. Full evaluation and understanding of progression potential are important points in the treatment approach. Surgery is frequently performed for helping the prevention of permanent major curvatures in the maturation period (13).

Neuromuscular scoliosis results in spinal deformities that challenge spine surgeons most. Common characteristics of neuromuscular scoliosis are large, rigid, progressive and long spinal curvatures in the early years of life. In addition, the presence of lower extremity contractures, pelvic obliquity due to imbalanced spinal deformity, sagittal plane deformities such as thoracic and lumbar hyperkyphosis or lumbar hyperlordosis affect the rehabilitation process in a negative way. Based on the imbalance of the muscles around the spine, deformities of these patients can progress rapidly not only during the growth periods but also at all ages independently of growth. Only some of the patients can be ambulated because of the spasticity and flaccidity that can develop due to contractures, hip dislocations, sensory abnormalities, mental retardation, pressure sore, upper and lower motor neuron involvement. Many patients in adolescence can move with wheelchair, which decreases their quality of life apparently. Large and rigid spinal curvatures can affect lung volume and respiration. Education on transferring from bed to wheelchair, positioning, nutrition, and hygiene are vitally important in rehabilitation approach. The aim of neuromuscular scoliosis rehabilitation is to maintain independence and functioning as much as possible. When these patients lose their function of sitting, their life qualities go down dramatically. Care after early surgery and ventilatory support in the intensive care unit is very significant because of extended spinal surgery performed on neuromuscular scoliosis. If there is enough quality of bone for implant fixation, corset is not generally used following the surgery. When correction of kyphosis is performed, orthosis is utilized in order to decrease the load over posterior fixation points in the proximal. The rates of complications may vary between 24% and 75% in neuromuscular scoliosis surgery. Patients should be followed closely with regard to wound infection, respiratory complications and urinary tract infection. Neuromuscular deformities are frequently complex, multi-plane and rigid. Prevention of contractures by using appropriate orthoses in the extremities, positioning for reducing hip contractures and pressure sores, choosing proper wheelchair and respiratory rehabilitation should be taken into consideration for these patients since many systems are affected.

Idiopathic scoliosis is the most common spinal deformity and makes up 80% of all scoliosis types. Infantile (0-3 years old) and juvenile (3-10 years old) idiopathic scoliosis is seen less frequently than adolescent (10-18 years old) idiopathic scoliosis. The frequency of adolescent idiopathic scoliosis, with a Cobb angle of more than 10 degrees, varies between 0.9 and 12%. Curvatures less than 10 degrees are assessed as spinal asymmetry (4,8). If the scoliosis angle exceeds the critical threshold (30-50 degrees) after the end of growth, more health problems, decrease in quality of life, cosmetic deformity, disability, pain and progressive functional restriction can be seen in advancing ages (9). In idiopathic scoliosis, the curvatures remain stable for a long time in many cases. Deformation progresses when osteoporosis and spinal degeneration begin. These progressive deformities must be cured but there is not enough evidence to prove that scoliosis can be treated with electrical stimulation, nutrition support, exercises, and manipulation therapy. It is reported that only the use of an orthosis can slow down the progress of idiopathic scoliosis. Nonsurgical treatment is therefore recommended.

FACTORS DETERMINING REHABILITATION PROGRAM AFTER the SURGERY of DEFORMATION

General Rehabilitation Principles

The aim is restore the patient to full function as early as possible without risking the surgical intervention performed. The spine surgeons accept early mobilization as a general principle in order to prevent deconditioning and to minimize the causes of other secondary postoperative morbidities. The surgeon decides on the necessity of postoperative use of orthosis and also the duration of corset use considering the stability and validity of instrumentation. Rehabilitation specialist applies general rehabilitation principles to help the patient achieve normal daily life activities. These are preventing the contractures that may develop with decrease in mobility, informing the patient about the ways through which he/she can do his/her daily life activities while using a corset (like the use of a high chair), and providing the patient advanced exercises for conditioning when the spine is stable. An important issue that needs to be considered when suggesting exercises to the patient during the rehabilitation program is to avoid excessive stress on the healing spine. Therefore, patients should keep away from exercises that put too much stress on healing regions while performing strengthening and range-of-motion exercises (7,11).

In conclusion, the approach of rehabilitation following spinal deformity surgery requires a good understanding of spinal anatomy, physiology, and biomechanics.

The Process of Osseointegration

Rehabilitation program should be based on basic science. The process of osseointegration should be comprehended by the rehabilitation team because of instrumentation usage and fusion during deformity surgery. Moreover, the surgeon and

the rehabilitation team should always be in cooperation with each other and exchange information.

Osseointegration is a direct functional and structural connection between living bone tissue and a load-carrying implant surface, which occurs without fibrosis and which can be seen through optical microscope (2). It is an important concept for the post-implant rehabilitation. In this process during which the titanium implant incorporates within bone permanently and cannot be separated without fracture, implant osseointegration is accepted to be completed when there is no movement between implant and directly connected bone. The process of osseointegration determines post-implant rehabilitation plan (3,6).

Osteogenesis occurs around the implant in the bone-implant interval and the newly formed bone surrounds the surface of the implant (peri-implant osteogenesis). Osteoblasts and mesenchymal cells migrate to the surface of implant one day after the implantation. Trabecular bone formation occurs in 10-14 days following the implantation. Lamellar bone and woven bone within 3 months after the implantation is seen around the titanium implants. Remodeling in the bone around the implant can continue for a year (6,12). The process of osseointegration, meaning the incorporation of the implant with bone, should be supported by the rehabilitation program. The instrumentation can loosen if an aggressive rehabilitation program is carried out before the completion of osseointegration (14).

Bone Graft- Spinal Fusion Incorporation

The primary components necessary for the success of spinal fusion are the presences of osteogenic cell, osteoconductive matrix, osteoinductive signal from the graft and enough level of local blood flow (5).

Inflammatory phase lasts for the first 1-2 weeks. Hematoma formation, inflammatory cell and fibroblast infiltration, formation of granulation tissue, increased vascular permeability, and revascularization occur during this period. NSAID use affects the healing response. Proliferative phase of wound healing is the 3 to 12 week period after the surgery. Formation of granulation tissue and Type 3 collagen are seen. Soft (fibrous) callus formation develops within 4-6 weeks and osseous callus formation develops within 12 weeks following the surgery. Maturation and remodeling phase may last from 3-6 months to one year. During the reorganization of scar tissue, type 3 collagen turns into type 1 collagen. Recovery of the original shape, structure and mechanical power occurs in this phase.

A well-planned post-operative rehabilitation program affects the results of spinal fusion surgery in a positive way. The formation of bone fusion is completed in about 3 months in average, but full maturation can last for several years. Fusion is no longer fragile after being completed and it gains strength against the stress applied since bone is a living tissue. Also, applying stress on the fusion area after the third month makes the spinal fusion region stronger. Generally, intensive activities can be started six months after the surgery. Many patients do not want to move because they think that moving can affect the development of fusion negatively. On the contrary, movement is necessary for accelerating the healing of fusion region.

Concepts of Neutral Zone and Elastic Zone and Importance of Muscles for Dynamic Stability

Panjabi stated that the region of physiologic motion in the spine has two components called the neutral and elastic zones (10).

The neutral zone is the spinal column consists of the midline region in the spine, close to the 1/3 back part of the corpus vertebra forming the functional unit. The motion of neutral zone is done by the most stable region of the segment, with minimal resistance. The column that moves less during the physiologic motions of the spine is the column of the neutral zone.

The elastic zone is the motion of the segment around the neutral zone and there is maximal resistance against the motion. The neutral zone forms the first segment of joint range-of-motion in the spine and the motion resulted from little forces on the spine encounters minimal resistance in this region. When the spine stabilization deteriorates and instability emerges, an increase occurs firstly in the neutral zone. The elastic zone forms the last part of the range-of-motion. Here, the spine acts against resistance and the resistance against this motion is created by the joints. If motion increases in this column, it means that the functional unit is unstable.

Stability of the spine depends on three main sub-systems, which are the osteoligamentous sub-system (passive system), musculotendinous sub-system (active system) and neural control sub-system. The components of passive sub-system are the bone and ligaments forming the lumbar spine. Active sub-system consists of the muscles having an effect on the spine. The neural control sub-system is the neural system controlling spinal stability and spinal position. Moreover, the neural control system monitorizes the spinal position in the case of expected or unexpected sudden changes for obtaining spinal stability. The neural system enables the stabilization of the spine through muscle control, by getting information from the passive and active systems. In the case of any change in one of these three systems and this change not being compensated by other systems, instability and pain appear.

The most significant system that can be strengthened after the surgery of deformity is the active system including the spinal muscles. This system transmits the spinal position and motion to the neural system.

The Concept of Core Stabilization

The core stabilization exercise program aims to strengthen the deep muscles stabilizing the spine and lumbopelvic muscles.

The purpose of core stabilization exercises is to teach the body muscles how to control the spine during dynamic mo-

vements. The activated key muscles are multifidi, transversus abdominus, internal oblique, paraspinal muscles and pelvic floor muscles. Of these muscles, multifidus and transversus abdominus are the most essential ones that need to be strengthened with these exercises. While ensuring the stabilization of the lumbopelvic region, multifidus should receive particular attention because it is an important lumbar extensor and stabilizer. In addition, it has deep and superficial fibers and segmental innervation. Deep fibers play a role in lumbar stabilization and the superficial fibers have a role in the protection of lumbar lordosis during the spinal motions. Transversus abdominus contributes to the stabilization of the spine by acting with the external oblique and internal oblique muscles through the thoracolumbar fascia.

The goal of core stabilization exercises is to strengthen the key muscles and to provide load transfer from the upper part to the lower part of the body by forming a corset of muscles in the lumbopelvic junction. This transfer provided by the strengthened body muscles continues during the actions like standing, sitting, walking, body movements and carrying any load (1).

The purpose of the rehabilitation following the surgery of spinal deformity is not only to strengthen specific muscle groups. The main goal should be to activate multi-muscle groups and motor patterns through anatomic connections. Not only the waist region but also the hip junction, spine and shoulder junction should be exercised together. Therefore, exercises such as swimming and walking that activate many parts of the body at the same time should especially be included in the rehabilitation program.

REHABILITATION PROTOCOL FOLLOWING the SURGERY of DEFORMITY

The pre-operative consultation process provided to the patients by the rehabilitation specialist is useful for preparing for the post-operative period. The exercise program is scheduled according to the applied surgical technique (anterior approach, posterior approach, anterior-posterior approach). Rehabilitation following the surgery of deformity consists of 5 main phases. Phase 1 is the pre-operative period, and education of the patient and the family is very important in this phase. Phase 2 is the active resting period, which consists of the time between the 1st day and 6th week after the surgery. Phase 3 is the maximum protection phase, covering the period of 6-12 weeks. Phase 4 is the minimum protection phase and it is the period between 6 months and 1 year. Finally, Phase 5 is the dynamic phase.

Phase 1: Pre-Operative Preparation Phase

The rehabilitation period should be started before the patient is operated. Education of the patient and family is highly important. They should be informed about the post-operative period before the surgery. It should be emphasized that the surgery is performed to decrease the risk of progression in scoliosis and the degree of existent scoliosis. Moreover, the problems that they may experience after being discharged from the hospital following the surgery should be explained to the patient and family clearly. They should also be warned about consulting the physician in the cases of bowel or bladder complications, unusual pain, numbness and tingling on the legs, wound discharge and increased fever that may develop after the surgery.

Phase 2: Active Resting Period After the Surgery (1st Day- 6th Week)

Depending on the general condition, patients stay in hospital for 1-2 weeks after the surgery of deformity.

The goals of the rehabilitation program in this period are pain control and mobilization. Patient education should continue during this phase. The patient should be educated about posture and informed in detail about spine protection principles and positions causing excessive stress on the spine that they must avoid (Table I).

Pain control is vital because it increases the comfort of the patient and also facilitates mobilization. Especially during the first 2 weeks, analgesics should be used regularly and pain control should be ensured for preventing any increase in pain.

In this period, if there is no special warning from the surgeon, patients should be walked for 5 minutes, 3-4 times on the 1st post-operative day. Short-walks are appropriate. The patient can feel dull pain, but he/she should stop walking in the case of sharp pain. The duration and frequency of the walking activity is determined considering the tolerance of the patient. Ladder exercises can be started.

In some centers, the use of a corset is suggested to provide more support to the patient.

The rehabilitation program accompanied by a physical therapist is begun on the 1st day after the surgery. The patient should be raised and mobilized at 48 hours following the surgery. Early rehabilitation is significant for preventing post-operative complications. An activity plan should be made and followed properly. Pain may occur in the post-operative period. Therefore, the exercise program should not be hindered and adequate pain control ensured.

In general, the patient can perform many daily activities within the first 2 months.

Phase 3: Maximum Protection Phase (6-12 Weeks)

In this period, exercises providing spine stabilization should be done by moving only arms and legs in the supine position and avoiding excessive spine movements. The body is not moved during these exercises. Pelvic tilt exercises in the supine position and standing position are begun (Figure 1,2).

Phase 4: Minimum Protection Phase (3-6 Months)

The first phase of dynamic lumbar stabilization exercises is initiated with the appearance of fusion formation on the radiological images (Figure 3). The goal is to activate the multi-muscle groups starting from the deep muscles around the spine through anatomic connections. Exercises such as swimming and walking which work a great majority of body muscles simultaneously should therefore be involved in the rehabilitation program.

Figure 1: Pelvic tilt exercise.

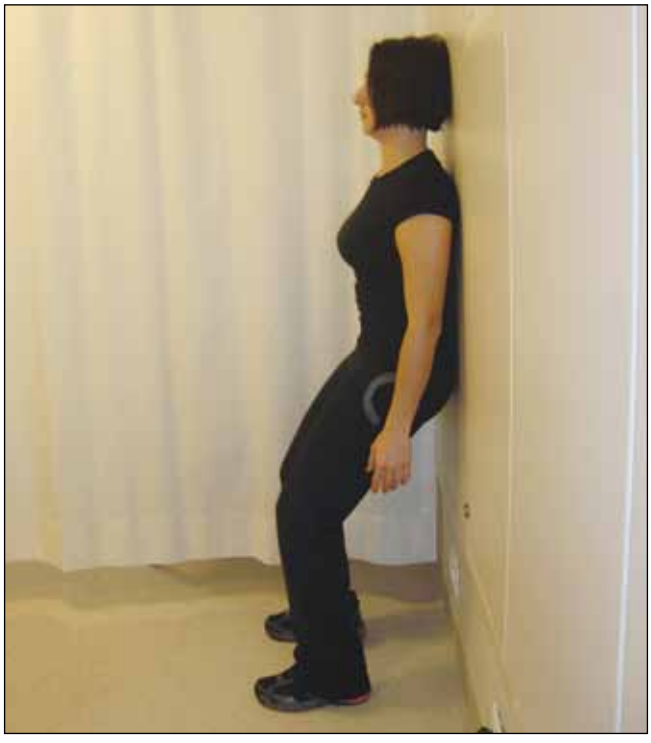

Figure 2: Pelvic tilt exercise in standing position.

Figure 3: Dynamic lumber stabilization exercise in supine position.

Figure 4: Flexibility increasing exercise in standing position.

Figure 5: Hamstring stretching exercise.

Figure 6: Flexibility increasing exercise.

Figure 7: Dynamic stabilization and flexibility increasing exercises.

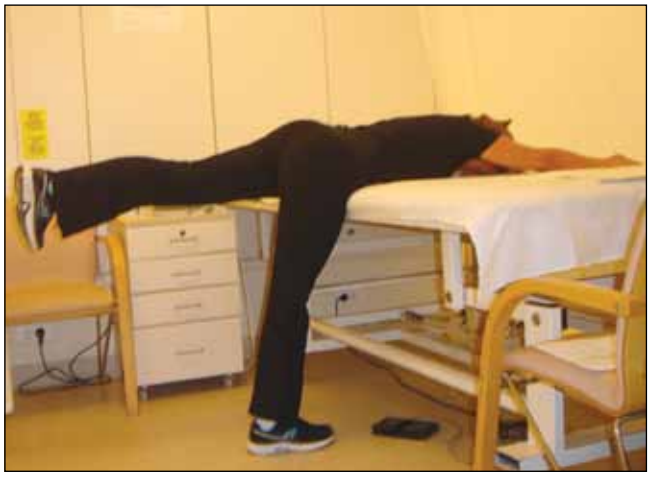

Figure 8: Flexibility exercise in prone position.

Figure 9: Dynamic stabilization exercise in standing position.

Figure 10: Cross dynamic stabilization exercise in standing position.

Figure 11: Dynamic stabilization exercise in prone position.

Şekil 12: Resistive spine stabilization exercise in standing position.

Table I: Spine Protection Principles after Deformity Surgery

Standing up from the bed: Hip and knees should be bent and turned over in the bed completely. After dangling the legs from the side of the bed, the patient should get to the sitting position with the help of the arms and hands. A bed that is a little higher than normal provides easier movement of hip and knees when standing and facilitates standing up.
Leaning forward: Leaning forward while bending knees is easier than spinal movement when leaning forward to reach an object. The patient should be taught to move from the knees to pick up an object from the floor.
Sitting: On the first days it will be easier to sit on a high or heightened chair with cushions. When standing up from the sitting position every time, the patient should take a 2-3 minutes walk as much as possible. While the position is changed when the spinal movement is realized without pain, it will be easier to sit on a normal chair and this process generally takes 3-4 weeks. The patient should be careful of sitting position after this period. Chairs supporting the waist region totally should be preferred. The patient should not sit in too soft and deep armchairs. It is suggested to sit straight and the spinal cavity must be supported by a small cushion. The patient should not sit in the same position for a long time but when it is necessary, it is suggested to stand up and take a few steps every 20-30 minutes and then sit down again. Sitting down on a chair and standing up exercises should be done.
Standing up from the chair: Standing up from a high chair becomes much easier. When standing up from a high chair, the patient should be taught to move his hips to the side of the chair and then stand up by taking support from the hands and arms and straightening the legs. The patient, while standing up, should not move by leaning forward from the waist. Ladder instruction should be given.
Going to the toilet: This may be difficult at the beginning. The use of a pain reliever can trigger constipation. Increased fluid intake, the use of a mild laxative when necessary and the use of a toilet heightener when pain is too much while sitting are helpful in the first days.
Bathing: With regards to wound care and preventing wound infection, it is suggested to clean up by wiping, taking a shower at first when the surgeon gives permission and taking a bath in the bathtub after the third month.
Dressing: In the first days, it may be easier to dress while lying or sitting on the side of the bed or the chair. When putting on shoes, long shoehorns can be used or methods reducing the load on the spine such as putting the foot on a chair should be told to the patients.
Housework: When the spine protection principles are taught, information to facilitate the life of the patient during housework should be provided in detail apart from what the patient needs to do for protection in daily life. During housework such as working on the kitchen bench, ironing, making up the bed, and using the vacuum cleaner, the general principles never change: the spine should be kept straight, and the knees should be bent, when leaning necessary. During ironing, the patient can sit on a high chair or the height of the ironing board can be increased. While using the vacuum cleaner, the cleaner's tube is extended and sweeping is done while walking instead of pushing and pulling the tube. While working on the kitchen bench, the spine can be kept straight by placing a footboard under a foot.
Shopping: The load should be divided into two equal parts. It is better to carry two handbags than one heavy suitcase. Heavy things should not be lifted for a long time. The lifted item should be kept close to the body. A shallow rather than a deep trolley should be preferred for shopping. Lifting weights while leaning forward should be avoided.
Having a rest during an activity: Everyone has a different healing rate after deformity surgery. As a general rule, the movements should be done slowly and the activity pace should be increased gradually. Targets should be set for the days after the surgery. Making an activity schedule and trying to follow it affect motivation positively. For example, the planned walking time for five minutes in the first days should be increased 1-2 minutes every day.
Driving: One should begin driving after the usage of corset ends. Before beginning to drive, it is important to have enough strength to use pedals. If pain occurs while getting in the car, it can be easier to sit first and then take the legs in the car. The patient should not sit for a long time in the car. It is necessary to get off the car and take a walk around the car from time to time.
Sexual activity: After the deformity surgery, the spine is not fragile. There is therefore no problem regarding sexual activity if the patient feels good and ready. This state of well-being changes from person to person. The activity schedule created by the patient gives a general idea about his performance.

Core stabilization exercises and exercises working the whole kinetic chain are important in this period. Not only the spine but also hip junction, the spine and shoulder junction should be worked together (Figure 4,5,6,7,8). The spine should be moved at the pain threshold. The patient should avoid bridge exercises and spine axial rotation exercises before the end of the 6th month following the surgery of deformity.

Phase 5: Dynamic Phase (6 Months-1 Year)

Fusion is completed to a great extent in this period. Dynamic spine stabilization exercises in the supine position, prone position and standing position can be performed (Figure 9,10,11,12). After a year, patients can get back to their normal life and sports activities. They should strictly follow spine protection principles.

GETTING BACK to a NORMAL LIFE AFTER the REHABILITATION PROCESS

With a well-planned and gradually increasing exercise program, patients can gain enough strength to perform many basic activities in a few months. The level of activity rises step by step, beginning first with walking outside and then going on with driving, shopping and regular exercising. Returning back to challenging sports and activities can be possible only in 12 months. Patients should go on to strengthening and resistance exercises gradually.

Getting Back To Work / School

The aim should be to return to work or school as soon as possible. There is no need to wait for all the pain to stop to go back to work and school. The time of getting back to work changes according to the type of work. Returning back to work is recommended 8-12 weeks after the surgery for desk jobs, in 4-6 months for jobs that require carrying light loads, and after the 12th month for jobs that require carrying heavy loads. These times refer to the incorporation of the implant into bone.

While planning to get back to work, the physician and the patient should talk about the type of work in detail. The exact durations of activities such as sitting, pushing, pulling, carrying, leaning forward, reaching, walking and driving should be determined. Moreover, the patient should be informed about the activities that may create problems and about strategies that can facilitate these activities. The patient can be encouraged to work for a shorter time at the beginning and then continue with working full time.

In the period of returning back to school, school time should not exceed a half day and should increase gradually. Getting on the school bus can be difficult at the beginning, so some support may be necessary. The patient is suggested to be 5 minutes late to class and to leave the class 5 minutes earlier in order to prevent the risk of being harmed in the crowd. While listening to the lesson in the classroom, he/she should sit close to the board so that he/she can see the board without turning his/her spine and neck. He/she should never carry heavy bags and prefer the back bags that are worn on two shoulders. He/she should not attend physical education courses for the first 3 months. Mild exercises can be done after the third month. Contact sports (basketball, football) should be avoided for 12 months.

As regards the rehabilitation program after deformity surgery, the main issues are patient education, teaching spine protection principles and avoiding exercises that will put excessive load on the healing spine after surgery. The osseointegration process should be taken into consideration, time intervals of tissue healing should be known by the rehabilitation specialist, and the patient should get back to normal daily life while keeping in touch with the surgeon continuously.

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