Seating

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Abstract

Introduction Patients with neuromuscular disorders are not able to adapt their sitting posture continuously. Seating devices, like seating orthoses, braces, seating shells, and custom-made cushions for wheelchairs, however may improve their quality of life by stabilizing their pelvis and trunk. Sitting should be regarded as a dynamic process regulated by motor reactions of trunk and pelvic muscles due to endogenic and exogenic influences.

Methods Prerequisites for the indication of high-quality and cost effective seating devices are guidelines for planning and fitting which consider both pathomorphologic mechanisms and the patient's personality. In order to avoid functional problems and pain caused by an insufficient seating device it is necessary to pay attention to the exact indication, time, and combination of technical options. Planning within a seating clinic needs teamwork. Primarily the goal of treatment is defined; it depends on the functional deficit, on the daily living activities of the patient, and on the social environmental factors. Secondly, fitting of the devices follows defined treatment guidelines.

Conclusion By examination of the sensor and musculoskeletal system, it is possible to classify the patient's sitting or seating ability for simplifying indication: three groups of ACTIVE sitters who are able to change position of trunk and pelvis actively are differentiated from three groups of PASSIVE sitters who have to be seated.

Keywords Neuromuscular spine deformities · Sitting · Seating · Technical aids for sitting and positioning · Seating devices · Seating shells · Wheelchairs

Normal sitting

Sitting is a typical posture of the resting human body which allows an individual to reduce energy consumption while being involved in communication, eating or working by using his hands. Sitting allows us to use our upper extremities in an intensive and concentrated way [1]. Sitting postures may be differentiated according to cultures, geographic regions, religious or traditional activities. Accordingly, devices built for the support of sitting postures differ in the same ways [2].

Biologically, sitting is defined as a dynamic process regulated by motor reactions due to endogenic and exogenic influences.

Like standing upright and walking, the ability to actively sit results from the refined performance of the human neuromusculoskeletal system, which has been developed by an evolutionary process.

Prerequisites of this development are the special shape and function of the human pyramidal system and human brain. The considerable increase of hip extensor power and corresponding muscle growth due to the body's upright position are also important factors in the possibility of long sitting periods in daily life [3].

Physiologically, the neuromusculoskeletal system allows for continuous adaptation of sitting posture to exogenous and endogenous influences. Thus, active sitting occurs unconsciously.

Permanently trunk and pelvic positions actively change between a front, straight seat position stabilised by power

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Active Sitting Positions

Fig. 1 Sitting positions that can only be controlled by ACTIVE sitters and should be simulated by swivelling frames for seating shells

of the spine extensors (“readiness position”), a middle, relaxed position, stabilised by the ligament apparatus of the spine (“resting position”), and a rear position, stabilised by a weight shift to the sacral bone of the spine (“weight-shift position”). See Fig. 1.

Sitting posture in cerebral palsy

In patients with cerebral palsy sitting may be compromised by lack of motor control and weakness of those muscles which should stabilise the trunk and pelvis. Severity of sitting disorders depends on the course of the disease.

Commonly these patients are handicapped by severe sitting disabilities due to spasticity, hypotonia, dystonia, ataxia, and over time, by developing secondary musculoskeletal deformities [4].

Problems usually are described as decreased upper extremity function, lack of head control, increased deficit of sensory functions, reduced time of sitting posture, back pain, and pressure sores [5].

Progressive fixed musculoskeletal deformities like scoliosis, kyphosis, hip dislocation, pelvic obliquity, severe muscle shortening, hip extension contracture, etc. considerably aggravate the patient’s seating and positioning problems [6].

Diagnostic tools of the seating clinic

Screening programs should be provided for all patients with neuromuscular disorders. Consultations should include a check-up of daily living activities, gross motor function, sitting posture, sensory and communication possibilities, hand function, head control, muscle length and strength, spasticity, pressure sores, pain, and function and shape of spine, hip and feet [7].

Documentation is recommended by using GMFCS scale, Goal Attainment Scale, Tardieu or Ashworth scale,

Oxford scale for muscle power of upper extremities, clinic muscle tests additional to ROM for lower extremities, X-rays of spine and hips, photographs of seating posture, and video analysis of upper extremity function.

Problems and new chances concerning sitting and positioning should be discussed. Treatment goals have to be defined by the team. Most important goals are improved trunk stability in weak patients and increased range of movement as well as reduced muscle tone for hyperactive, spastic, or dyskinetic kinds of diseases [8].

Establishing a seating clinic has become a main task for neuroorthopaedic treatment centres [9]. Members of the seating clinic’s team are patients, parents or caregivers like nurses, physical therapists, occupational therapists, orthopaedic technicians, neuroorthopaedists, and neuropaediatricians or neurologists.

Professionals should be trained to work together regularly, using the same language, and translating it to the patients. Their task is to analyse problems, define the goal of treatment and create a rehabilitation plan for how to get there. Seating is an important part of that plan. This plan is composed of interventions immediately improving daily living activities whereas others may require more time or even associated therapy [10].

The team should always agree on the best possible individual seating concept. They need to conclude and document their recommendations using any kind of standardised form, such as the Goal Attainment Scale, for follow-up and evaluation.

Re-evaluation, adaption of seating units and prescriptions for new devices should be considered once a year and every 6 months for the growing child.

Principles of seating

Indication for the best individual seating system belongs to the most challenging tasks of specialists in neuro-orthopaedics.

Biomechanical and technical orthopaedic fundamentals, medical essentials and the requirements according to occupational and physical therapists have to be considered as well as the needs and desires of the patient and the parents [11].

The optimum outcome is a comfortable seating device improving function that helps the patient to increase his participation in social life. It should include an upright position of the trunk with a balanced head position [12]. The pelvis should be positioned in three dimensions, physiologically with bilaterally flexed and slightly abducted hips. A fixed windswept deformity requires an asymmetric seating position. A flexible windswept deformity has to be corrected by sufficient pelvic fixation [13].

Optimal pressure distribution by a surface as large as possible reduces the risk of pressure sores.

One of the main goals of seating is to achieve free function of upper extremities and reduced spasticity of trunk and extremities. Sitting should be comfortable for several hours.

Care and transfers should be eased so that they can be performed by a single person only. The devices should provide enough flexibility and stability for daily life functions, and they should comply with hygienic and aesthetic standards [14].

Classification of sitting ability and recommendations for special devices

ACTIVE SITTING is defined by the ability of the patient to control his trunk and pelvic muscles actively by an intact motor system. This allows for continuously adapting the sitting posture to the environmental conditions. Patients are able to sit ACTIVELY [15]. See Figs. 2 and 3.

PASSIVE SITTING is defined by the patient's inability only to be SEATED by supporting seating aids. He is not able to change the position of trunk and pelvis actively due

Fig. 2 Definitions and examples for ACTIVE sitting–PASSIVE seating

1. Active Sitting – person is able to change position of trunk and pelvis actively by intact motor system

2. Passive Sitting – only by seating aids; person is not able to change position of trunk and pelvis actively

Fig. 3 Overview: classification of sitting ability and recommendations for special devices

ACTIVE SITTING

A1: FREE SITTING

A2: SITTING with POSTURAL DEVIATION
→ adapted seat

A3: SITTING with SPINAL DEFORMITY
→ brace

PASSIVE SITTING

P1: SITTING with MILD SPINAL INSTABILITY
→ pelvic stabilization

P2: SITTING with SEVERE SPINAL INSTABILITY
→ pelvic-, trunk-, head stabilization

P3: SITTING with SEVERE NEUROMUSCULAR DEFORMITY
→ pressure relief technique

Table 1 Active sitting

A1 FREE SITTING	Active change of sitting posture corresponds precisely to environmental conditions. Permanent unconscious active adaption by using front, medium, and posterior sitting position. Even long-term sitting does not worsen the ability of the patients to adapt his activity	Standard chair or wheelchair Recommendation: Anatomically shaped seat and back padding Dorsal pelvic support Arm support Leg support
A2 Free sitting with POSTURAL DEVIATION	Scoliotic or kyphotic postural deviation can be controlled and corrected actively. Fair neuromuscular coordination but slight muscular weakness, overuse or incipient progressive muscle disease. Sitting for several hours causes severe postural deviation and decrease of sensor and motor function of upper extremities	Anatomically shaped seat and back padding Positive angle >90° for activating spine extensors Dorsal pelvic support Arm support Leg support
A3 Free sitting with DEFORMITY of spine or trunk without possibility of passive therapeutic or active correction by extensor muscles.	Structural deformity of the spine due to congenital or neuromuscular scoliosis or kyphosis or severe muscle weakness due to progressive muscle dystrophy or spinal atrophy. Active sitting by strong and well-controlled lower or upper extremity muscles has been demonstrated. No pathologic muscle tone.	Anatomically shaped seat with additional stabilising brace Arm support Leg support Common indication for spine surgery

Table 2 Passive sitting

P1 Sitting with MILD TRUNK INSTABILITY due to poorly coordinated trunk muscles but sufficient power of the spine extensors	Common sitting disorder in bilateral spastic and dyskinetic CP. Stabilising the pelvis makes it possible for the spine extensors of the patient to provide sufficient stability for partly active sitting	Anatomically shaped seat and back padding with stabilisation of the pelvis Positive or negative angle Stepped seat padding Swivelling frame Therapy table with grab pole Arm support Leg support and guidance
P2 Sitting with SEVERE TRUNK INSTABILITY due to poorly coordinated trunk muscles and insufficient power of the spine extensors	Common sitting disorder in severe bilateral spastic and hypotonic ataxic CP. No severe structural musculoskeletal deformities. Severe spine instability commonly causes secondary motor, sensor and coordination deficits of head-, mouth-, hand function. Stabilising the pelvis DOES NOT make it possible for the spine extensors of the patient to provide sufficient stability for partially-active sitting	Anatomically shaped seating shell with stabilisation of pelvic, trunk and head Positive or negative angle Stepped seat padding Swivelling frame Therapy table with grab pole Arm support Leg support and guidance Consider additional brace Consider spine surgery
P3 Sitting with SEVERE NEUROMUSCULAR TRUNK DEFORMITY due to fixed spastic-rigid or contracted pelvic-spine deformity	Common sitting disorder in late or very severe cerebral, spinal or muscular movement disorders. Asymmetric contractures, spine deformities, hip dislocations. Because of muscular dysfunction compensation is not possible. High risk for pressure sores, especially in the region of ischial tuberosity, proximal femur, costal arch, axilla. High risk for secondary pulmonary disorder	Seating shell shaped by vacuum or digital measuring with pelvic, trunk and head stabilisation Pressure relief technique Positive or negative hip flexion angle Stepped seat padding Swivelling frame Therapy table with grab pole Arm support Leg support and guidance Consider hip or spine surgery

to a disorder of the motor system. Trunk, pelvic and lower extremity muscles cannot be moved voluntarily or are done so inadequately. Without seating aids the patient would slide to a severe asymmetric posture or would drop out of the chair. Such patients have to be seated **PASSIVELY** (Tables 1 and 2).

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