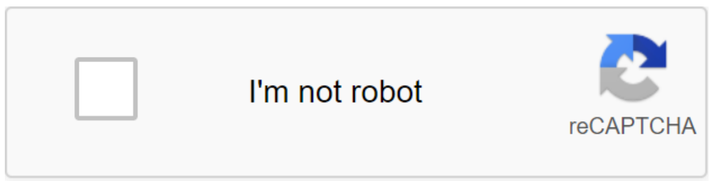

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Cerebellar ataxia physiotherapy pdf

Damage to the cerebellum can lead to an attacking gait, which affects the ability to walk safely and independently. Physiotherapy is the main treatment for astaxia gait, but there is limited high quality evidence for activities used. This review explores the neural mechanisms of astaxial gait symptoms, discussing the role of the cerebellum in coordination, motor training, pre-emptive postural control, balance reactions and gait adaptation to meet environmental needs. It discusses the mechanisms that occur at the cellular level throughout the cerebellum, and then focuses on the difficulties that arise as a result of damage to specific lobes of the cerebellum. Physiotherapy interventions, such as balance training, postural control, specific gait training and the use of compensatory orthotics and aids, are discussed in connection with a theoretical understanding of cerebellar functioning. The difficulties associated with the use of trial and error techniques that will affect the methods and training strategies used during gait rehabilitation are considered. This theoretical understanding will help physiotherapists focus on their assessment, treatment, management and goal setting with individuals who have difficulty with astaxiaic gait after cerebellar damage. Keywords: Cerebrellanic ataxia; Gait; Physiotherapy. Donate Health Unlocked Twitter Facebook Youtube Instagram Cerebellum is essentially involved in traffic management and plays an important role in motor learning. It remains debatable whether patients with degenerative cerebellar disease benefit from high-intensity coordination training. In addition, it remains unclear by which the methods and mechanisms of training these patients can improve their motor characteristics. Here we look at data from various high-intensity educational studies in patients with degenerative spinal diseases. These studies show that high-intensity coordination training can lead to significant benefits in patients with degenerative ataxia. This training can be based either on physiotherapy or on full-body video games (exergames). The advantage shown in these studies is the recovery of one or more years of natural progression of the disease. In addition, the first case studies show that even subjects with advanced neurodegeneration can benefit from such training programs. For both types of training, the observed clinical improvements are simultaneously restored to specific ataxia dysfunctions (e.g. multifunctional coordination and dynamic stability). It is important to note that for both types of learning, the persistence of the effects appears to depend frequency and continuity of learning. Based on these studies, we provide preliminary recommendations on clinical practice and formulate open questions that could guide future research on neurorehabilitation in degenerative spinal diseases1. diseases1. The cerebellum is essentially involved in controlling various types of motor behavior such as speech, eye movements, limb movements, and balance. Here its main function is the formation and fine-tuning of movements. Accordingly, damage to the cerebellum does not lead to reduced or paretical movements, but to increased variability and low precision movements (ataxia). For example, astaxial gait is characterized by deficits, such as disorderly coordination between the head, torso and legs, and disorders of predictive postural adjustments, such as impaired predictive postural adjustments in balance control and multifunctional foot coordination. These deficits are present as increased step width, variable leg placement, irregular leg trajectories, and resulting instable stumbling walking track with very high 6-8 motion variability and high risk of falling. Given the fact that drug interventions are rare in degenerative diseases and are limited to a specific type of disease and symptoms, physiotherapy is the main cornerstone in the current therapy of astaxial gait. However, while motor training programs have been shown to be beneficial in other neurodegenerative diseases (e.g. Parkinson's disease or stroke 11, 12), their effectiveness remains controversial in the field of degenerative spinocerebellar ataxias. Degenerative ataxias really seem to be the most difficult group of ataxias to treat. Here, Motor training is not only challenged by the fact that cerebellum is crucial in motor adaptation and motor training, but also challenged the progressive nature of this type of disease and, moreover, the fact that virtually all parts of the cerebellum suffer (although degeneration is often most noticeable in the middle line (20). And. In contrast, ataxia after stroke, neurosurgery, or injury usually affects only the circumcised areas of the cerebellum, but leaves other regions intact. These regions can compensate for defective parts. In addition, in the case of focal lesions, the effects of neural plasticity are probably more effective because there is no competition with the current progressive neurodegeneration (22, 23). In addition, while patients with focal lesions clearly improve motor function over time, degeneration patients are slowly deteriorating. Thus, in patients with progressive degenerative diseases, it would be a great achievement if they remain stable on the current state of motor function as far as possible or if the progression of functional disorders slows down. Until recently, only few and small clinical studies evaluated training interventions for patients with spinal coronary ataxia. Using Using requiring balance and gait tasks, improvements have been made in terms of increasing postural stability and reducing dependence on walking aid (26, 27). It was suggested to train on treadmills with body weight support (28, 29) or without body weight support, especially for patients with heavier ataxia who cannot walk freely. However, many of these studies have had isolated cases or based on a very small number of patients and do not focus on degenerative spinocerebellar ataxias, but on nondegenerative secondary ataxias. In clinical practice, this problem is complicated by the fact that not only the basis of scientific data for physiotherapy is a rare, but also ataxia-specific experience among physiotherapists. A large proportion of physiotherapists report a lack of specialized knowledge specific to ataxia and expresses the need for education and evidence-based guidelines (31, 32). Here we provide an analysis of the first recent clinical studies that have systematically investigated various training programs in significant cohorts of patients with degenerative cerebellar disease. Supported by encouraging findings from animal studies that demonstrated the motor effects of learning in mice with degenerative cerebellar disease even at the molecular level, these studies provide the first systematic evidence of the effectiveness of motor rehabilitation in this condition in humans. Here we will look at their findings, identify their most important achievements and limitations, present clinical practice recommendations and formulate new research questions that could guide this area over the coming years. This targeted review could also contribute to the first steps towards the development of evidence-based recommendations and specific education for physiotherapists2. MethodsSearch Strategy. The selective, targeted search was carried out by the authors in the electronic databases PubMed, Medline and EMBASE. It was felt that these databases were likely to cover all relevant clinical trials in this area and, in particular, contain all studies that meet the strict inclusion criteria mentioned below. Clinical trials have been identified using a combination of meSH terms and terms: cerebellar ataxia, ataxia, physiotherapy, physiotherapy, training, exercise and rehabilitation. The selected time period was from January 1, 1980 to December 18, 2013, and the articles were to be published in English. The extracted articles were considered useful links. Choice. Articles are included if they meet all the following criteria: (i) an initial report, but not, for example, conference abstracts or reviews; (ii) Prospective clinical trials that evaluate physiotherapy or other motor training programs focused on gait and position (e.g. computer training, treadmill training or video game-based training); (iii) Highly intensive training over the course of the Extended period of time, defined as repeated continuous exercise without interruption, for at least 45 minutes per workout with 3 workouts and 3 hours per week for 2 weeks; (iv) control design (case-control design or intraindividual control), but not uncontrolled thematic or cohort studies; (v) The recruitment of patients with spinal corderebellal degeneration, but not with secondary cerebellar ataxia due to, for example, stroke, tumors, injuries, inflammatory or autoimmune causes (for a systematic review of educational studies in these patients; see Spinocerebellanic Degeneration should have been the primary feature in these patients. : Prospective cohort studies on long-term motor training in degenerative Cerebellar AtaxiaMaes have extracted research using combinations of terms and MESH terms mentioned above. studies have been excluded because they do not meet at least one of the five inclusion criteria. Three studies have been identified that examined high-intensity motor training in a large cohort of patients with degenerative spinal coronary ataxia (for review, see table 1). These studies examined the following training strategies: physiotherapy in combination with occupational therapy; physiotherapy focused specifically on exercises that challenge complex coordinated behavior (coordination physiotherapy); and training with full-body video games (exergames). Another study was identified, in which only a case report (on exer proceedings for advanced multi-system degenerative ataxia) was presented, but it also met the inclusion criteria. Physiotherapy in combination with occupational therapy 35th number of patients421610Type diseasesSCA6 (20), ADCA (6), and IDCA (16)SCA6 (2), SCA2 (1), ADCA (1), IDCA (6), FRDA (3), SANDO (2), and SN (1)FRDA (4), arCA (3), AOA2 (1), and ADCA (2)Age sD (range: 40-82) (range: 44-79) (range: 11-20)Gender22 men, 20 women8 men, 8 women5 men, 5 Women Notice of the Disease (7 months-30 years) (3-25 years) Basic SARA (5-21.5) (11-24) (7-13.5)ControlCrossover for short-term effectIntrendidvid control of short-term effectIntraindivid controlsEvidence classClassClass IbClass III EvidenceClass III EvidenceIntervenation2 hour - 5 days - 1 hour 2 days a week for 4 weeks1 hour, 3 days a week for 4 weeks1 hour and 4 per week for 2 weeks in the laboratory; variable frequency in subjects of their own motivation for 6 weeks at homeAfter NoOutcome protocols measuresSARA, FIM, gait speed, cadence, FAC, and fallsSARA, gait speed, balance, BBS, GAS, and traffic analysisSARA, balance, scale ABC, ABC, scale, gas and traffic analysis, after 0, 4, 12, and 24 weeks before, baseline, and after 0, 8 weeks2 weeks before, base level, and after 0Main resultsSARA and gait improved 12 wks, but not 24 wksSARA and gait improved 8 wks after rehabilitation only in patients with cerebellar ataxia not afferent ataaras and gait improved directly after rehabilitation; improvement correlates with the intensity of human training at home: spinocerebellal ataxia; FRDA: Friedreich's ataxia; IDCA: idiopathic cerebellar ataxia; ADCA: autosomal-dominant cerebellar ataxia of unknown type; SANDO: sensory attackic neuropathy with dysarria and ophthalmopares caused by mutations in the gamma polymerase gene; SN: sensory neuropathy with cerebellar degeneration; arCA: autosomal recessive cerebellar ataxia of unknown type; AOA2: ataxia with class 2 oculomotor apraxia; SARA: Ataxia assessment and evaluation scale; ABC: Balance-specific confidence scale; BBS: Berg Balance Score; Gaz: Scaling the target; DGI: dynamic gait index; FIM: Functional measure of independence (38); and FAC: functional categories of ambulation. The evidence was evaluated according to the Oxford Centre for Evidence-Based Medicine (CEBM) classification. This table provides details of the first three clinical studies of motororeability in larger cohorts in degenerative spinal diseases (34-36, 43). 3.1. Physiotherapy training 3.1.1. Physiotherapy, combined with occupational therapy, usually targets one or more of the

following areas, often combining a mixture of them: balance, gait, coordination, strength, endurance and posture. One recent study combined a mixed multidomain physiotherapy strategy with occupational therapy, testing this intervention in 42 patients with cerebellar degeneration by a randomized controlled study design with a delayed-entry control group. Subjects were prepared for an aggregated amount of 12 hours per week for 4 weeks. The authors observed an improvement in ataxia severity, gait speed, frequency of fall and activities of daily life, as defined by the Functional Independence Measure (FIM). A more specific clinical assessment of ataxia on the ataxia score and score scale (SARA) showed an improvement of 2.1 points immediately after a 4-week intervention (immediate and delayed entry groups are aggregated). The SARA scale extends from 0 to 40 points, with higher scores indicating a heavier ataxia. The progression of natural diseases of degenerative cerebellar attacks is 0.4-2.2 points per year on the SARA scale, depending on the genotypes. This means that the average improvement achieved as a result of this type of training is equivalent to improving the functional performance of one or more years Disease. Improvements were more noticeable in the trunk of the ataxia than in the limb of the limb and patients with mild ataxia severity experienced more sustained improvement in attack symptoms and gait speed. Long-term follow-up data were collected within 24 weeks of the intervention. Although the functional condition tended to decline to baseline during this period, more than half of the patients maintained an improvement of at least 1 point of intervention results at 24 weeks compared to baseline. Patients with sustained improvement had a less severe ataxia (i.e. a lower SARA score) than patients without sustained improvement, indicating the possible predictive value of the SARA assessment and thus the severity of ataxia at a baseline. Because of the design of the study, the intensity of the learning was not different between the subjects, making it impossible to correlate between the intensity of learning and the benefits of learning. No quantitative analysis of the movement was carried out and the evaluations in this study were not blinded.3.1.2. Coordinating physiotherapyO a recent training study aimed specifically at static and dynamic balance within the physiotherapy program, which focused on demanding coordination exercises (coordination physiotherapy) (more on exercises see the following table 4). This strategy has been tested in an intraindividual design control case in 16 patients suffering from progressive ataxia due to cerebellar degeneration () or degeneration of afferent pathways. Subjects were trained 1 hour a day, 3 days a week for 4 weeks under the supervision of a specialist physiotherapist ataxia at the ataxia center, and then 12-month home-schooling under the patient's own guidance. A 4-week center-based physiotherapy resulted in a 5.2-point improvement on the SARA score immediately after the intervention. This means an average achievement equivalent to getting back functional performance for at least two years or more of the natural progression of the disease. Clinical evaluations were further supplemented by an analysis of quantitative movements independent of tariffs. This analysis revealed improvements in several aspects of gait, such as speed or lateral influence, as well as in the temporal and spatial variability of the gait (e.g. step length, step cycle time). The variability of these measures was discussed as a risk factor for falls in the elderly, as well as in subjects with cerebellar ataxia. In addition, it reduced the temporal variability of intralimbic coordination in gait, a measure that has been shown to be specific to patients with cerebellar dysfunction. Patients with cerebellar ataxia benefit more significantly from the intervention than patients with afferent ataxia. This discrepancy is most likely caused by the loss of afferent information in these patients, which removes the necessary sensory inputs for adequate cerebellar processing. Long term and their real-world transfer was assessed 12 months after the four-week intervention period. Intervention. these 12 months, subjects were trained in an individual homework protocol combining different coordination exercises and degrees of difficulty, depending on the level of human function and the success of the training. Despite the underlying progression of the disease, SARA's grades were still significantly better on this long-term follow-up than at the base level for the cerebellar group by 3.1 points (Figure 1). This indicates the persistence of training effects, which is equivalent to getting back at least one or more years of natural disease progression. The group of patients with afferent ataxia was stable compared to the baseline. Regardless of the type of ataxia, the intensity of training in coordination exercises is largely correlated with differences in SARA scores after 1 year, which indicates that the preservation of training effects is crucially dependent on continuous training. (a) (b) (b) Assessment of achievement (GAS) has been used to capture the translation of educational effects into actual functioning. To do this, each patient chooses a personally significant goal that reflects the individually important activities of everyday life (e.g. table 2 and 3). These goals were defined before training and achievement was assessed on the following scale: No2 - functioning as at the baseline, No.1 - less than expected result, 0 - expected result, No.1 - more than expected result and 2 more than expected result. For all patients, the average score was 0.57, which is higher than the expected level of achievement. Individual goal: walking around the table with little distance, without swaying ScoreThe patient walks around the table basically, touching the table No. 2 Patient can walk on the table without touching the table most of the time No. 1 The patient can walk around the table without touching the table 0The patient can walk around the table without touching the table, and he can look around the no.1 patient can walk around the table without touching the table, and he can look around all the time No. Estimates range from 2 to 2 (basic figure, 1 euro less than expected result, 0 expected result, 1 more than expected result, and 2 much more than expected result 35). PatientGoalScoreC1 Walk on the narrow lt;50 cm)2C2Walking up a 'staircase' without using a railway q 2c3reaching' the mailbox in a distance of 600' without using a walking aid0c4walking around a table with a small distance A walk of about 300 m without walking or assisting a person2C7 Walk 50 m away with a trolley without bumping into it 1C8 Walk free lt;/50 cm)2C2Walking small stairs (3 steps) in alternating 1m to the railway With a trolley at a distance of 50 m 0C10 Walks without assistance when walking at a distance of about 100 m0A1 Walk yourself over long distances (500 m) 1A2Reduc the danger of falling 0A3 Walk at a distance of 30 m with a full cup without spilling something 1A4 Walk with a trolley at a distance of 2000 m without falling leg and strong support from the hand. 1A5 Walk 100m with a trolley and no bumping foot into it 2A6 Walk with a trolley at a distance of 500m No 1 Described goals match the score of 0. Estimates range from 2 to 2 (basic figure, 1 euro less than expected result, 0 expected result, 1 more than expected result, and 2 much more than expected result 35). Static Balance (i) Standing on one leg. (ii) quad standing: stabilize the torso and raise one arm. (iii) Quad standing: stabilize the torso and lift one leg. (iv) Four-core standing: Raise one arm and leg of the other side. Dynamic Balance (i) On your knees: put one foot in front and back one at a time. (ii) Knee: Put one foot to the side and back one by one. (iii) Kneeling: put one foot in front, stand up and put one foot on your knees one by one. (iv) Standing: swing your hands, see seen knees. (v) Standing: step aside. Vi) Standing: Step ahead. (vii) Standing: Step back. (viii) Standing: cross by step. ix) Climbing the stairs. (x) Walking on uneven ground. All body movements to learn Trunk-Limb Coordination (i) quad standing: lift one arm and leg of the other side, flexible hand, leg and torso, and extend the arm, leg and torso alternately. (ii) Morning Prayer (Moshe Feldenkrais): Kneeling: Bend your legs, arms and torso (sitting package): you will extend your legs, arms and torso one by one. (iii) Kneeling: sit next to the heel on the right side; on your knees: Sit next to hell on the left side alternately. Steps to prevent fall and fall strategies to prevent injury (i) Standing: step aside, step ahead, step back, and move a step into dynamic change. (ii) Standing: The therapist pushes the patient in modified directions; The patient must react quickly with the drop preventing steps. Standing: Bend your torso and knees to touch the floor and erect the body one by one. (iv) Standing: bend the torso and knees, touch the floor and contact the four-legged standing, (v) Standing: the therapist pushes the patient; The patient must react quickly and go to the floor in a controlled manner (vi) Walking-therapist pushes the patient- the patient must react quickly, bend, and go to the floor in a controlled manner. Movements to treat or prevent contracture Especially shoulder and spine movement (i) Spine enlargement: prone to lie: push the shoulder girdle from the prone to lie; lying on a wedge. (ii) Spine rotation: lying on your back: knees bent, turn your knees to the right and left side, (iii) shoulder flexion: lying on your back: raise your arms in the direction of the head.3.2. Exercise based on exergami3.2.1. Exergames Training in soft to moderate degenerative ataxia Physical therapy exercises can be supplemented (or used interchangeably with) whole-body training based on newly developed commercially available video game technology (exergames). An exergistic-based learning strategy can have a number of benefits, particularly if it is used as a continuous long-term training for chronic diseases. Exergame exercises include highly motivational incentives for reward and resort to a variety of stimulating and stimulating exercises. (ii) Exerga-based training includes interactive exercises in rapidly changing environments that could mimic and train actual patient activities and the possibility of anticipating coordination. (iii) Patients with mobility impairments do not need access and transition to external physiotherapy practices, but may be trained at home. Thus, taken together, exergames can introduce a new, profitable treatment tool for training patients with neurodegenerative diseases. This can allow patients to train coordination exercises in a highly motivational and playful way in their own homes and with low financial costs. A directed exergames-based training program was recently researched in 10 children with progressive spinal ataxia mild to moderate (i.e. all subjects could still walk without support). Researchers selected three commercially available Microsoft Xbox Kinect video games that were specifically selected for targeted propulsion capabilities known to be dysfunctional in ataxia, namely, targeted limb movements, dynamic balance, and full-body coordination (Figure 2). The training program began with a two-week phase of laboratory training under individual supervision and under the guidance of a physiotherapist who presented games and adequate strategies for moving to subjects. During these two weeks, subjects were trained 1 hour a day, 4 days a week. This initial phase of training was followed by 6 weeks of home-schooling, during which patients were asked to continue exercise based on exergies at home. The effects of the training were assessed in the design of unprepared control. Sara's ratings were performed in a dazzled fashion, which was achieved by presenting a video of one SARA exams of individual subjects at random to a rateer who was dazzled by the number of particular exams. These estimates, blinding them, showed a decrease of an average of 2 SARA points after 8 weeks (Figure 2), which indicates an achievement equivalent to receiving at least one or more years progression of the disease. Improvements in ataxia during home training thus depended on the intensity of home training: the more intense the periods of training at home, the higher the decrease in the gait and posture of SARA. Clinical improvement in the severity of ataxia has been in parallel with improved gait quantitative indicators (lateral impact, step length variability) (Figure 2) and, more importantly, improvements in ataxia-specific dysfunctions such as multifunctional coordination and dynamic stability. This included complex full-body movements, very relevant to everyday life, such as rapid step movements to compensate for the perturbations of the gait and prevent falls. Improvements have also been transferred to other movements, indicating the effect of generalizing basic control mechanisms induced by exergames. These findings show that learning exergames gives some impact on ataxia and dynamic balance that goes beyond mere improvements in subjects' game scores, motivation and fitness. The training was very motivational for all subjects involved throughout the training period. (a) (b) (d) (d) (b) (b) ()(e) (f) In general, this study suggests that the directional preparation of body-controlled video games may represent an environment of a highly motivational, cost-effective and home-based rehabilitation strategy to teach dynamic balance and interact with a dynamic environment for subjects with chronic coordination disorders.3.2.2. Exergames Training in Advanced and Multi-System AtaxiaExergame-based training can improve coordination in subjects with mild to moderate spinocerebellar ataxia. However, it remains an open question whether it is also effective in subjects with advanced degenerative cerebellar diseases that are already confined to a wheelchair and, moreover, where ataxia is part of a multi-system disease affecting many additional pathways of the central and peripheral nervous system. It is believed that these subjects benefit greatly only from poor treatment, as evidenced, for example, by the fact that they are usually excluded from ongoing drug treatment trials (45, 46), leaving them without the prospect of access to a new treatment. A recent study provided the first evidence of the principle of evidence that exercamine-based co-ordination training can indeed serve as an effective treatment even for advanced, multi-system degenerative ataxia. Researchers used a consistently structured 12-week coordinating training program based on specially selected, commercially available Nintendo Wii games in a child with advanced telangiectasia ataxia (AT), which was already largely disabled The results were evaluated in a management design with estimated blindness. The authors observed an improvement of 4.4 on the SARA scale, which was most pronounced in posture and residual gait gait Accordingly, subjective ratings of achievements in GAS show a marked improvement in the balance in the sitting position and position. These results seem to indicate that, despite progressive multi-system diseases (including oculomotor and cognitive deficit), exercology-based coordination can lead to significant effects that lead to daily life. However, these preliminary results need to be confirmed in a broader cohort study before firm conclusions can be drawn.4 DiscussionThe above described studies provide the first evidence for significant cohorts that high-intensity motor training may be effective in degenerative ataxia. In particular, they provide evidence of the concept of proof that (1) patients with degenerative ataxia benefit from cosy training that can be based either on physiotherapy or on exergames; (2)improvements equal to the recovery of 1 or more years of natural disease progression; (3)) improvements not due to non-specific changes, but due to recovery in attacks of specific dysfunctions; (4)retention of learning effects depends on continuous learning; (5) Even subjects with advanced neurodegeneration benefit from these treatments; (6) Even children with severe illness can be very motivated to train throughout a challenging program, and that they experience a sense of success about their own movements.4.1. Open questions and future studiesTo be promising, the above studies have important limitations. These restrictions stimulate new research questions that could lead to this in the coming years. Larger cohort studies are justified in confirming the above findings. Since degenerative ataxia refers to orphan diseases with a prevalence of about 6 : 100,000, this will require a coordinated multicenter effort to aggregate larger cohorts. These cohorts should be more homogeneous. The phenotypic and genetic variability between the various degenerative ataxia is great, including various disease progressions and different comorbid attachment of additional neural systems (21, 49, 50). Thus, future research should ideally resort to cohorts with foreseeable, homogeneous genotypes. In addition, they should aim to use a randomized control design to create higher levels of evidence. The intraindiual management design used by three of the four above studies No.34, 43, 47 has several attractive advantages, since the issues here are taken as their own controls and thus between-groups of differences in disease progression and comorbid different neural systems can be excluded. However, the randomized design of management is still methodologically superior, and the delayed entry of the design as employed in the study of Mia and his colleagues ensures that also the control group will receive the benefits of propulsion training. In addition, research should use a multicenter structure, as only this design can prove that training can really be a go to other centers and therapists. Future research should also focus more specifically on identifying predictors of learning success. The type of ataxia may serve as a predictor, as evidenced by the conclusion of Ilga and his colleagues that patients with afferent ataxia benefit less than patients with cerebellar ataxia (34, 35). However, this might not at all be true as younger patients with afferent ataxia (namely, Friedreich ataxia) still benefited well from xbox-based exergame training. Another predictor may be the severity of ataxia at a baseline, as suggested by the conclusion of Mia and his colleagues that patients with heavier ataxia had less sustained improvement through training. But, again, this usually may not be true, as evidenced by the conclusion of Synofzik and colleagues that a wheelchair subject with advanced degenerative ataxia still achieved a significant improvement of 4.4 points on the SARA scale. Finally, a specific level of residual cerebellar integrity can be a predictor of the ability to improve engine performance. Studies conducted by subjects with focal cerebellar lesions (e.g. due to stroke or tumor) have shown that, in particular, the integrity of deep cerebellar nuclei can determine the future success of rehabilitation (51, 52). Changes in neural mechanisms and substrates underlying the effect of learning in degenerative ataxia are still largely unclear. Is the degenerative cerebellum still able to adapt motor coordination or, instead, learning deficits compensated by other brain structures? In an attempt to portray brain changes that improve motor function, Burciu et al. Two-week postural training has resulted in a significant improvement in balance in degenerative patients. Comparison of gray matter before and after training showed an increase mainly in non-infective neocortic areas of the cerebellar-cortic loop, in particular the premotor cortex. Changes in gray matter were observed in the cerebellum, but were less pronounced. Thus, these early data suggest that training can lead to activation and plasticity of compensation networks and, to a lesser extent, even to the remaining cerebellar circuits. Further imaging research on neurorehabilitation strategies will lead to a better understanding of the underlying pathomehanisms of disordered motor characteristics and learning. This can help to adapt physiotherapy to the specific needs of patients with cerebellar ataxia.4.2. Preliminary Effects on Practice: Physiotherapy vs. Exergames-Wrong DichotomyDecementDecementDecement, the aforementioned studies give some preliminary hints of the link between learning protocols. These tips stimulate future research by testing these ideas and studying them in more detail. The experience of these studies shows that exergamal training can and should not replace physiotherapy. It could rather serve in addition to physiotherapy-based programmes, helping subjects achieve and maintain the necessary intensity of learning even over a long period of training and practicing specific coordination skills, such as adapting quickly to changing environments and updating predictions to new external events. These skills are desperately needed in real-world situations where actors need to respond adequately under time pressure to make ever-changing environmental conditions and accurately anticipate new developments and their impact on their own sensory engine system. Both of these skills have been shown to be impaired in degenerative cerebellar diseases (54, 55), but they are less trained in conventional physiotherapy compared to exergames. By learning in an interactive, ever-changing environment with many new unexpected events, exergames better simulate real-world situations. Well-chosen games (Figure 2) effectively improve these very valuable coordination skills, as shown recently (43, 47, 56). However, the experience of the above studies also shows that any exergamal training should be initiated and monitored to a variable degree by a physiotherapist. The specific experience of this professional is necessary to select appropriate exergames in accordance with each person's coordinating capabilities, degree of impairment and current treatment goals. Only this selection and observation can ensure that the patient is neither overly or underchallenged, which will quickly lead to a lack of motivation. In addition, it ensures that the patient is not predisposed to risky movements that can lead to falls and other injuries. Finally, it seems preferable that, at least during the first training sessions, the physiotherapist will actively train the patient how to make adequate complex coordination movements when trying to solve exergamal problems. We noticed that ataxia patients initially often try to play these games, reducing their repertoire of movement even more, trying to keep their center masses within their support base, making themselves tough and actually avoiding complex movements. If this derivative strategy of the compensatory movement is consolidated in the continuation of the game, it may lead to a further loss of coordination skills, i.e. cause a downward spiral, which indicates that exegram-based training may even be harmful if not applied properly. Parallel training and supervision of a physiotherapist is likely to help the patient avoid such wrong movement strategies and relearn how to do complex movements, even if seem risky at the beginning.4.3. Recommendations for clinical practice, based on the aforementioned studies, emerge a new concept of ataxia learning in clinical practice. The concept still had to be put into practice and should therefore be seen as a preliminary rather than a final proposal. However, this may stimulate future research and clinical rehabilitation practice. This concept is characterized by the idea that rehabilitation in degenerative ataxia should optimally resort to a wide range of different learning strategies that must be individually adapted according to each individual's ataxia, disease stage and personal training preferences. In the earliest stages of ataxia, even demanding exercise can be selected to work with high-level coordination problems such as table tennis, squash or badminton. These real sports can be complemented by demanding XBOX Kinect games (such as Light Race or 20,000 Leaks) or Wii games (such as PhysioFun). These games can be played on an elastic mattress to increase the focal point even more. In the ataxia stages, a light to moderate coordination physiotherapy program led by a professional physiotherapist is of great importance. This may include preparing safe fall strategies in addition to learning to avoid falls. The exergs-based training component can switch to slightly less complex XBOX or Wii games, such as rope walk or ski slalom. In the later stages of ataxia, there is no clear evidence based on a physiotherapy training program yet to exist. However, in severe cases where free standing and walking is no longer possible, treadmill training 28-30 with potential weight support can be useful for increasing walking opportunities (using vehicles) and keeping overall physical fitness as far as possible. The component for learning an exelective game should be limited to Wii games, as XBOX Kinect games cannot play items that are tied to a seated position. Here, the test subjects will sit on the Wii balance platform, which then serves to detect the weight shifts of the trunk. Candidates for the respective Wii games include a penguin slide, tilt table, or bubble balance (47). Taken together, such individual learning strategies could maximize the use of each individual entity's function in his or her specific state of the disease and, at least in some cases, slow down the possible downward spiral of ataxia-related immobility and further deterioration of coordination functions. Finally, rehabilitation of degenerative diseases will remain a problem for patients, doctors and therapists. However, recent benefits in both clinical rehabilitation and motor adaptation studies in cerebellar diseases will stimulate research and hopefully lead to a greater knowledge in this complex area of motor rehabilitation and, finally, to improving the quality of life of patients. Abbreviations: The goal of achieving scoreSARA: scale for assessing and evaluating ataxia. Conflict of interestThe authors state that there is no conflict of interest in the publication of this paper.Dr. Mathis Sinofzik has contributed to the development and conceptualization of the study, the acquisition of clinical data and the analysis and interpretation of the data, as well as the development of the document. Dr. Winfried Ilig contributed to the development and conceptualization of the study, the acquisition of clinical data and the analysis and interpretation of data, and the development of the document. Confessions Of This work was supported by Ataxia UK, Ataxia Ireland, German Hereditary Fund Ataxia (DHAG), Katarina Witt-Stiftung, and Robert Bosch Stiftung Forschungslegkol Geriatrie (number 32.5.1141.0048.0 to M.S.). 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