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Sportsneurology – Concussion, Peripheral Nerve Injuries and Beyond

Neurologische Sportmedizin – weit mehr als Gehirnerschütterungen und periphere Nervenschäden!

EDITORIAL

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Sports-neurological problems have been gaining attention in recent years in clinics, practices and science. Recent clinical and scientific developments in particular and prominent cases of sports-induced mild craniocerebral injuries („concussions") have contributed to create sensitization for sports-neurological topics. These, however, go way beyond concussions in sports and offer considerable possibilities for prevention and therapy in sports and through sports.

„Sports-neurology" is the most rapidly-growing section within the American Academy of Neurology (AAN) (4). This is due to a continuously increasing interest and the associated increasing clinically-relevant knowledge with respect to sports-induced mild forms of concussion, which are prevalent and important especially in the contact and collision sports popular in Anglo-American countries, like American football, rugby and hockey. In Germany, too, the importance of the topic has justifiably increased in recent years, since concussions cause increased problems in the clinical management of other types of sports. However, thanks to other structures in organized German (elite)sports and in the medical care system there is need in many areas for a more adequate medical care of as well as practice-relevant research into concussions (1).

Craniocerebral injuries / Concussion

One important sports-neurological area can be defined using concussions as an example. This includes, among other things, the diagnostics and therapy of concussions, as well as management of return-to-play and return-to-performance, and more especially development and application of prevention strategies to prevent such injuries. Publications of the „Concussion in Sport Group", which are updated at regular intervals, offer evidence-based guidelines for treating the injury in practice (11). Interdisciplinary cooperation of all specialties involved (such as accident surgery, general medicine, pediatrics, physiotherapy, neurology, neuropsychology, neuroradiology, etc.) is essential for a good therapeutic result. When the recommendations and guidelines are followed in actions and treatment, concussion has an excellent prognosis, since up to 90% of the cases will then heal without sequelae (1) This chance must be used and, through sensitization for the topic with appropriate transfer of knowledge, care taken that the rate of chronification and secondary diseases be reduced.

Since there is currently no valid diagnostic biomarker for the presence of a concussion, it is important to reduce the number of unreported cases by corresponding knowledge among all doctors involved in sports medicine of the injury mechanisms and their effect on brain functions, symptoms and clinical examination findings. By the same token, it is up to all sports doctors to make their contribution to increasing the vigilance in the general population engaging in (high-performance and leisure) sports and that patients, caregivers and family members act appropriately with respect to these injuries.

The spectrum of central sports-neurological injuries extends, however, well beyond concussions (19). Other (more serious) forms of sport-induced craniocerebral traumata are considerably less frequent than concussions, but treatment methods are also usually more clearly defined.

Peripheral Nerve Damage, Central and Peripheral Overload

The sports-neurological-traumatological spectrum is completed by peripheral nerve injuries. Important diagnostic-localization knowledge can already be obtained by clinical-neurological examination taking sport-specific movements into consideration (18). Supplementary electrophysiological examinations go further to help characterize the damage (e.g. axonal vs. demyenisating) and thus in the prognosis and therapy management, even if systematic analyses are rare and often hardly enable evidence-based statements. In recent years, MR-tomographic evaluation of peripheral nerve damage has become established (14).

Overload damage, which may affect both the musculoskeletal apparatus and peripheral nerves, for example as part of a compression syndrome, must be delineated from sport-induced injuries (17). Here, too, it is necessary to intervene through early recognition, if necessary in the training processes, to prevent protracted clinical course. In addition to the diagnostics with respect to localization and extent of the damage, solid knowledge of the individual sport-type specific details of the patient's training and exercise patterns is essential. Modifications of these form the decisive ›

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therapeutic approach following the initial exercise pause. Less well known (and prevalent) than the typical peripheral overload damage (such as compression syndromes of the wrist among cyclists or the shoulder in tossing sports), are overload-induced central damages like the presumably ischemic-induced surfer-myelopathy in the spinal marrow (classically first described in Hawaii)(3) or foot dystonia among runners (5), which still often remain unrecognized. The latter, like the (Type 1) Yips which are seen in many types of sports) can be classified among the centrally-caused focal dystonias, in which genetic and acquired factors, along with overloading, play a role in the genesis.

Moreover, there have been hints for about 20 years that overtraining and the overtraining syndrome as associated with dysregulation as part of overload in the central segments of the autonomic nervous system (ANS) (9), which open clinically and scientifically interesting perspectives when the anatomy and physiology of the ANS are taken into account. From a sports-neurological point of view, multidimensional ways of considering the various components of the nervous system (including the ANS) are elementary in the management of (over)load in sports. In this, however, taking the inter- and intraindividual variability in the ANS into account is of the greatest importance. Oversimplification of this high-grade complex system would lead to a deceptive certainty in the interpretation of ANS data and thus to invalid statements. Under adequate inclusion of the control mechanisms in the ANS, appropriate evaluation methods and algorithms offer considerable diagnostic and therapeutic chances and possibilities, not only for the patients but also as part of training and performance management.

Neurological Sports Therapy

The most rapid development up to paradigm changes in sports (and physical activity) has occurred, however, in the past decades in neurological and neurodegenerative diseases, which due to increasing incidence and prevalence have become a problem not only for the individual patient but socially relevant as well. While patients used to be advised to refrain from active sports in many neurological diseases, there is now evidence that most patients can engage in sports with no significantly higher risk than the normal population, taking where needed disease-adapted safety measures, for example in multiple sclerosis (12) and epilepsy (2). In the latter, the patient's individual seizure situation is especially important for sports-neurological advice, since potentially dangerous types of sports must be avoided. However, the broad spectrum of various types of sports almost always offers an alternative so that even according to the recommendations of the Task Force „Sports and Epilepsy“ of the Internationale Liga gegen Epilepsie (ILAE) , there is no patient group with epilepsy that must categorically be excluded from sports (2).

So although sports can be engaged in safely in neurological diseases, most neurological patients exercise considerably less than the normal population (2, 12). These patients thus not only miss out on the general preventive effects of sports and physical activity, but also the therapeutic effects which affect their own diseases. The concept of stroke prevention through sport and physical activity has already been defined and applied in practice based on the vascular etiology. That the effect in the reduction of mortality may even surpass that of drug therapy (13) is, however, just as impressive as it is surprising when one considers how few patients have regularly engaged in sports to date. Encouraging are also studies which confirm that the relative risk of developing Alzheimer's dementia can be reduced by up to 45% by regular sports and physical activity (7). Similar epidemiological and meta-analytical data can meanwhile be found for many neurological and neurodegenerative diseases. In addition to the symptomatic effects, the boundaries between preventive and therapeutic effects become blurred. How else can it be explained by immunological processes that the episode rate in multiple sclerosis can be reduced 27% by regular sport training s (15)?

In principial, there no longer any „no-go“s of sports and physical activity among neurological patients. As in nearly every other specialty, positive effects can be described in any stage of disease at various levels and to various extents. The point is to find the appropriate measure of sports and physical activity for the patient. Since here, however, the possibilities have no limits, the goal is to integrate more of these therapeutic chances into treatment plans in the future.

Sport as a Neurological Apothecary

At the present time, therefore, the question is usually not whether, but how sports and physical activity are most effective in patients with neurological diseases. Traditionally, most intervention studies examined the effects of endurance and/or strength training, usually with positive results. Determination of surrogate markers of neuroplasticity in serum and neuronal imaging have confirmed the knowledge, already obtained in several animal models, of the mode of action of physical training on the brain (16). Clinically, larger quantities of data provide initial knowledge on the therapy effects, duration and dose-effect behavior (10, 21). Here is certainly the greatest and most challenging, but probably also the most rewarding task for the sports-neurological future. The standardization of non-endurance- & non-strength-based interventions (e.g. as part of coordination training) and combinations of these with other training and exercise forms is scientifically difficult. But if we want to make more effective therapy recommendations in future, we need animal-experimental and clinical studies which take into account the complex structure and function of the brain as well as the varied design possibilities of sports interventions, even going beyond the load forms of endurance and strength. The effects of general physical and athletic activity must be viewed differentially with respect to outcome parameters like incidence/prevalence of the disease in question, progression, functionality etc. Coordinative exercise, for example, also induces neuroplastic changes at many levels in animal models (8) and in the human brain (20), but is rarely mentioned in guidelines for sports activities in neurological diseases (since there are often no evidence-based data available).

If it is possible in future to individually dose combinations of various forms of exercise and to systematically record the effects, immense therapeutic possibilities would arise from a sports-neurological point of view. It would mean that sports would be not only a medication, but rather like an apothecary from which we could apply various effective "tablets" in differing doses and application forms – a principle that is important for the brain perhaps more than for any other organ.

Conclusion

The growing popularity of neurological sport medicine in the Anglo-American countries mentioned at the beginning is ascribed to the „concussion epidemic“, and not without reason (6). For the overall medical care of athletes, as well as of patients, however, additional sports medical aspects of sports-neurological injuries, neurological overtraining and overload damage and especially the sports therapy of neurological and neurodegenerative diseases are important.

For the development and implementation of clinically relevant innovations and practice-relevant, scientifically founded research in Germany, we must succeed in coupling specialist neurological and sports medical expertise and shaping it for (organized) sports and sport therapy. This can lead in the long term to a continuously growing improvement in the health and care of athletes, and to optimized care of neurological patients by strengthening the promotion of health in and through sports.

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