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### Management of ventilator-dependent tetraplegic patients in a Physical Medicine and Rehabilitation Neurological department

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**Materials and methods.**— Retrospective study of patients with assisted ventilation on their admission to the neurological physical medicine and rehabilitation department of the University Hospital of Nantes.

Evaluation of the clinical and electrophysiological respiratory status, mode of ventilation on admission and 3 months later, the duration of ventilator weaning, lifestyle after discharge.

**Results.**— Six patients including 5 men, 1 female admitted between 1993 and 2010. Mean post-trauma survival time: 4.4 years [1–8.5], one patient died 8.5 years post-traumatic.

On admission, the neurological level of injury was C2 in 5 cases, C1 in 1 case. Five patients were AIS A, 1 AIS C. All the patients had a volumetric ventilation mode by a tracheostomy tube, cuff inflated.

The outcome at 3 months post-trauma showed a recovery of the diaphragmatic function in 2 patients with a level of injury becoming C3 in these 2 patients, staying C2 in 3, C1 in 1. All patients were ventilated with volumetric mode leakage, deflated cuff.

For these two patients, a respiratory autonomy was obtained in the first year after the injury, at least 12h/24 (mean duration of the weaning: 9 months), including in one the removal of the tracheostomy tube. The electrophysiological finding confirmed the recovery of a voluntary control. The remaining patients have a complete motoneuronal lesion. Two patients were discharged at home, three are still hospitalized (objective of a discharge at home for 2).

**Discussion.**— The clinical and electrophysiological evaluations, patient disconnected from the ventilator, have to be performed every 3 months in order to detect a late diaphragmatic recovery, to distinguish the type of the lesion (upper vs. lower motoneuronal lesion) and to discuss diaphragm pacing or phrenic reinnervation.

The management of ventilator-dependent tetraplegics has to be performed in the context of an holistic approach, including all the goals of the rehabilitation of these patients: the control of an electric wheelchair, home and environmental adaptations, access to computers, management of the urinary function.

Patients with ventilator-dependent tetraplegia have to be managed in regional reference spinal units, close to home and allowing discharge at home.

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### Virtual-reality, robot-assisted rehabilitation training for people living with limited hand function

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**Keywords:** Hand function; Robot assisted training; Virtual reality

Restoration of hand function is most important for functional activities of daily living, independence, community re-integration, and thus, improved quality of life. Hand and arm movements are much more complex than leg movements and require greater precision and 3-dimensional control. Rehabilitation research and assistive devices for improving hand function will necessarily be a more demanding goal. Virtual-reality, robot-assisted movement therapy is new and the current status will be summarized in relation to other more established rehabilitation approaches, including: 1) constraint induced movement therapy (CIMT), 2) sensory stimulation (e.g. functional electrical stimulation, FES), 3) movement strategy training (pre-planning visualization), and 4) task specific physical and occupational therapy. All forms of active rehabilitation can provide benefit, but those patients who have retained at least some limited hand function are likely to show the greatest improvement. It is hoped that robot-assisted movement the-

rapy will complement and extend the efforts of therapists. Rehabilitation training has to be enjoyable to improve patient compliance and long-term outcomes and many patients find the virtual-reality environments both challenging and entertaining. Active rehabilitation also requires a training continuum that extends beyond sub-acute (in-patient) therapy and tele-health (in-home) approaches will be presented. Regardless of approach, there are still several unresolved issues to answer before rehabilitation training can be optimized, including: 1) when to start physical and occupational rehabilitation, 2) which rehabilitation regimen is best for each type of neurological disorder and when should training of compensatory behaviors be included, 3) are achieved benefits task specific or can you train multiple functional activities/modalities (simultaneously or concurrently), 4) how to best measure rehabilitation effort, 5) what duration is required for each rehabilitation session, 6) what frequency of sessions is required per day or week, 7) how many weeks of rehabilitation are required to recover a specific functional capacity or activity of daily living, 8) how long will any beneficial effects be sustained, 9) what type of maintenance programs are required, and 10) what are the reasons for lack of compliance or maintenance of rehabilitation by patients?

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### Charcot-Spine

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**Keywords:** Charcot-Spine; Spinal cord injury; Spinal arthrodesis

Charcot-Spine (Charcot's arthropathy of the spine) is a neurogenic arthropathy concerning essentially spinal cord injured patients, leading to a progressive destruction of spinal ligamentous and osseous structures and thus to a major spinal instability.

Few cases are reported in literature. These papers often describe the role of previous extended spinal arthrodesis, above or below the site of Charcot-Spine, or a laminectomy at the level of arthropathy's development. Mechanical hyperloading is one of the major physiopathological phenomena. This constraint concerns a sub-lesional spinal segment of which bone metabolism is disturbed by vegetative system anomalies.

Spinal neurogenic arthropathy diagnosis may be difficult, especially in case of lack of follow-up. Pain is a variable symptom. Sometimes a modification of the neurological status, like the loss of sub-lesional reflectivity, leads to the diagnosis. Radiological signs are non-specific. Radiographies or CT scan show a destruction of the three spinal columns and MRI shows an infiltration of soft tissues. These images may suggest an infectious process which can often exist in the history of the patient.

Surgical treatment must include a large resection of abnormal tissue and a circumferential arthrodesis for which we must take care about the initial level of the spinal cord lesion.

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### Neurological and functional outcome of spinal cord injury on cervical spondylotic canal stenosis

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**Keywords:** Spinal cord injury; Cervical spondylotic canal stenosis

**Objectives.**— To study the functional prognosis of spinal cord injury (SCI) on cervical spondylotic canal stenosis

**Patients and methods.**— Monocentric retrospective study of 63 SCI patients due to cervical spondylotic canal stenosis admitted to the university hospital of Nantes during the period 2000–2010.

**Results.**— The studied population consisted of 50 men (79.37%) and 13 women (20.63%) with a mean age 61.1 years (range 30.5 to 88.2). The SCI was due to a fall in 77.78% of cases and traffic accidents in 22.22% of cases. The initial ASIA Impairment Scales were AIS A in 4 cases (6.35%), AIS B in 6 cases (9.52%), AIS C in 22 cases (34.92%) and AIS D in 30 cases (47.62%). The initial motor level was C3 in 4 cases C3 (6.35%), C4 in 18 cases (28.57%), C5 in 22 cases (34.92%), C6 in 6 cases (9.52%), C7 in 6 cases (9.52%) and C8 in 1 case (1.59%). 66.66% of the patients underwent surgery in a mean delay of 50 days (range D1-D213). Three patients died at the acute phase. At discharge, the analysis of the ability to walk showed that 52.38% were able to walk without devices, braces or physical assistance; 25.40% walked with canes or crutches, 12.70% used a manual wheelchair and 30.63% an electric wheelchair. Concerning the mode of voiding: 71.43% recovered a spontaneous micturition, 7.94% had an indwelling catheter or suprapubic cathete, 4 performed self intermittent catheterization, 2 were on intermittent catheterization by a care giver. Four patients underwent urological surgery: one sphincterotomy, one continent cystostomy, two non-continent urinary diversion (Bricker). 58.73% returned to home without caregiver, 15.87% with care giver, 14.29% were in geriatric nursing home.

**Discussion.**— The analysis of this cohort confirms the data of the literature: the etiology of the trauma is mainly a fall in elderly subjects, the lesions are more often incomplete and the evolution is mainly favorable. 66.66% of the patients underwent surgery, this fact may explain the favorable outcome of our cohort, but this point is still debated in the literature.

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### Evaluation of the long-term results of functional surgery of the upper limbs in tetraplegic individuals

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**Keyword:** Surgical rehabilitation of the tetraplegic upper limb

**Introduction.**— Tetraplegic patients who receive a program of upper limb functional surgery followed by appropriate rehabilitation improve their prehensile capacities, and activities of daily living. But very few studies have evaluated the long-term results.

**Goal.**— To evaluate the outcomes of rehabilitative surgery of the upper limbs after a minimum of five years.

**Method.**— All tetraplegic patients having undergone rehabilitative surgery of the upper limbs more than five years ago at our centre were called in for re-evaluation.

Evaluation focuses on:

- standard analytic measurements of the upper limb: range of motion, muscle strength (BMRC), and sensory evaluation;
- assessment of different types of prehension;
- functional independence;
- patient's satisfaction: VAS, and a satisfaction questionnaire.

**Results.**— 68 patients underwent surgery, 9 deceased, 11 live abroad, 12 lost to follow-up, 36 responded and 25 agreed to participate (70% of those who responded), that were evaluated by two different methods. In the group of 13 patients "reviewed" the majority of patients improved analytical and functional remains at a distance with a great satisfaction. There are two cases of secondary syringomyelia occurred in which the benefit is more limited in the long term.

In the group of 12 patients who were accepted to be interviewed that functional outcomes are worse in 5 patients but the degree of satisfaction remains high on average. We find again a case of syringomyelia.

**Discussion and conclusion.**— Initial results show that patients who are stable in terms neurological keep the long term performance of gripping and functional independence equivalent to those obtained early. Patients are very satisfied with the long-term outcome and would recommend this surgery in a similar case. In three cases of syringomyelia results were not maintained, which demonstrates the need to track this complication.

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### Kinematic patterns of modified grasp (tenodesis) in C6 quadriplegic patients

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**Keywords:** Tenodesis; C6 tetraplégia; Kinematic

C6 quadriplegic patients can achieve functional grasp using tenodesis effect. Grasping kinematics of modified prehension after tetraplegia have been poorly reported in the literature. This study investigated the kinematic parameters in pointing and tenodesis grasping in these patients.

Four complete C6 quadriplegic patients and four healthy subjects were included. Each subject performed three different tasks: i) pointing to two targets with the forefinger, ii) reaching for and grasping a 7 cm diameter apple; iii) reaching for and grasping a vertical floppy disk.

Movements were recorded with an optoelectronic system at a sampling rate of 50 Hz. The kinematic parameters computed were: Movement Time (MT), Peak Velocity (PV), wrist extension and pointing accuracy.

In both pointing and grasping tasks, patients showed a longer MT associated with a weaker PV compared to control subjects. Pointing errors were slightly more pronounced in the sagittal plan. In the grasping tasks, the main difference was observed for the wrist angle. During the transport phase, quadriplegic patients presented a more pronounced wrist flexion compared to control subjects. During the grasping phase, tetraplegic patients achieved a more important wrist extension known as "tenodesis effect".

Active wrist extension in quadriplegic subjects occurs later after the onset of movement, unlike the early opening of the hand in control subjects, indicating that this grasp using tenodesis reflect an intentional compensatory mechanism.

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### Compared duration of hospital stays according to the age of traumatic SCI patients hospitalized for the surgical treatment of a pelvic pressure sore by myocutaneous flap at the University Hospital of Nantes

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**Keywords:** Spinal cord injury; Pressure sore; Aging

**Aim.**— To compare the duration of hospital stays after surgery for pelvic pressure sore by myocutaneous flap between two groups of traumatic spinal cord injured patients according to the age.