Effectiveness of sling-based exercise training (NEURAC) in patients with CNS lesion

[슬링을 사용한 기능적 운동치료]

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재활1팀 물리치료2파트장 민 원 규
Certified Neurac Practitioner

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민원규

- 1997년 세브란스병원 입사
- 2004년 2월 석사학위
- 2016년 2월 박사수료(현 논문 준비중)

- 2006년 한국보바스협회 보바스베이직 이수
- 대한재활의학회 주관 중추신경계발달재활치료 실습 주강사(2007~2016)

- 2010년 Neurac 1
- 2011년 10월 Neurac 2 Back & Pelvis, Neck, Stimula course
- 2012년 9월 Neurac 2 Upper Body
- 2012년 10월 Neurac 2 Lower Body
- 2016년 6월 Neurac 3
- 2016년 Certified Neurac Practitioner (뉴렉치료 국제인증)
- 2018년 HALmethod level 1,2 Instructor

- 2014, 2015 대한척수손상학회 연자 (척수손상환자를 위한 슬링운동)
- 2017 대한소아재활발달학회 연자 (소아척수손상환아를 위한 슬링운동치료)
- 2018 대한척수손상학회 연자 (High level tetraplegia 환자를 위한 슬링운동치료)
- 연세대학교 사회과학대학, 삼육대학교 물리치료학과 출강
- 2016년, 2017년, 2018년 수원여대 슬링운동 특강

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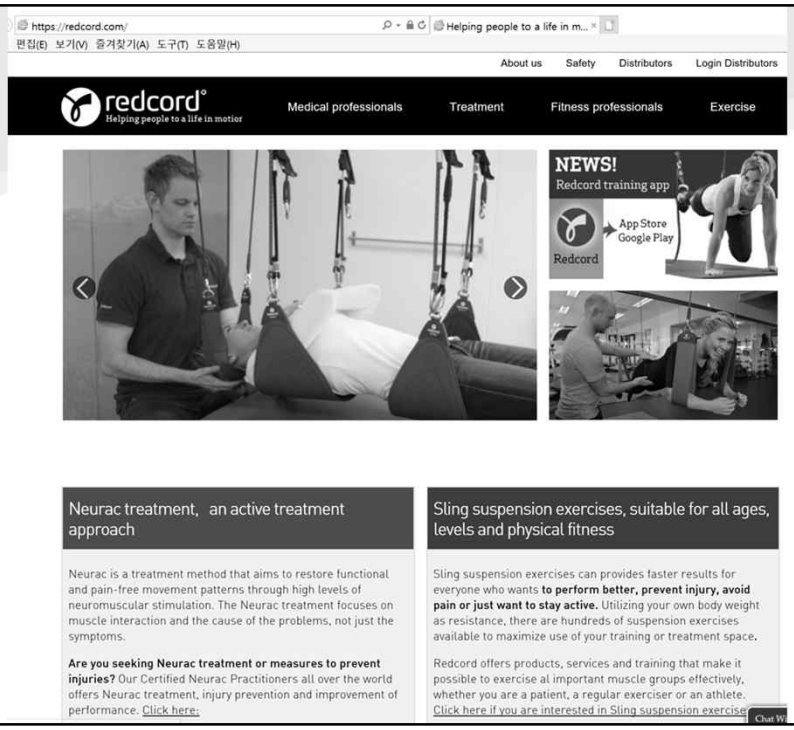
Redcord history

- ✓ Since 1991 ➔➔ 1997년 한국 도입
- ✓ 노르웨이의 Nordisk Terapi
- ✓ **의사**와 **물리치료사**들과의 공동연구
- ✓ **치료(therapy)**와 **운동(Exercise)**에 대한 종합적인 컨셉으로 **흔들리는 줄을 이용한 슬링운동치료를 개발**
- ✓ Worldwide
  - Manual Support
  - Sling Exercise Therapy
  - **Neurac**
    ➔ **Neural Activation**
  - **Neuromuscular re-education**

3



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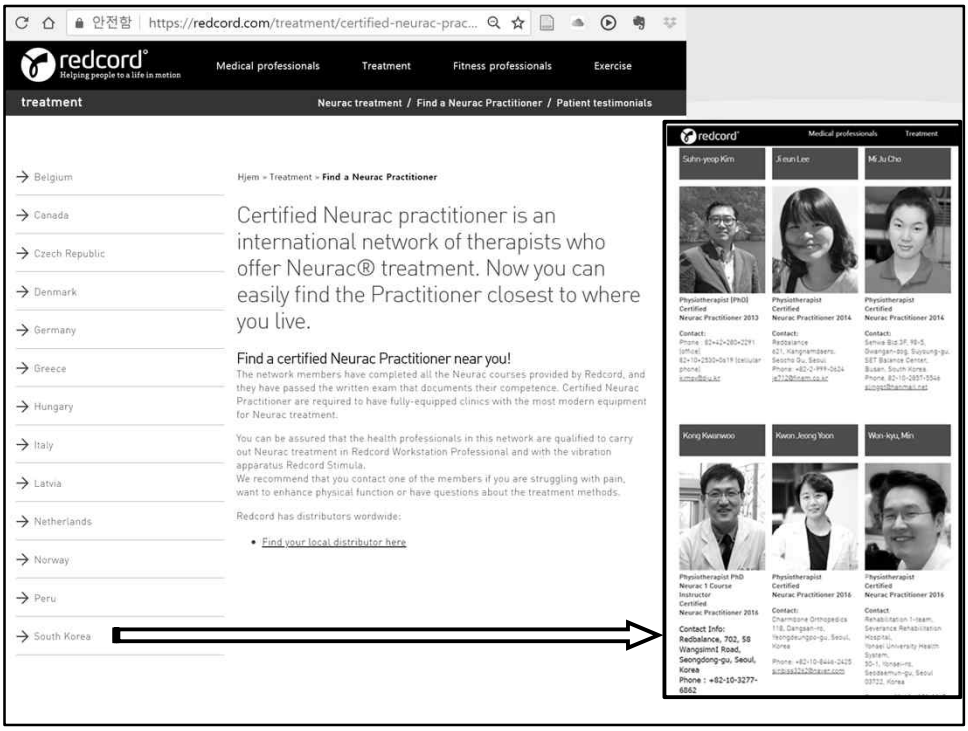
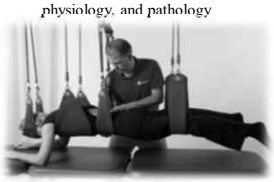


5

Redcord Education Program

Therapy and Rehabilitation
Courses for Physiotherapists and other licensed health professionals with an academic background in anatomy, physiology, and pathology



redcord MEDICAL

- Neurac 1
- Neurac 2
- Neurac 3
- Workshops
- Certified Neurac Practitioner

Wellness and Fitness
Courses for Personal Trainers, Pilates Instructors, and other professionals who work with wellness and fitness for individuals or smaller groups

redcord ACTIVE

- Redcord Active Introduction
- Advanced
- Specialist
- Workshops

Athletic Performance
Courses for trainers, coaches, and other professionals who work with performance enhancement and injury prevention

redcord SPORT

- Performance
- Sport Specific

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Redcord – The Common Thread!

redcord® MEDICAL

redcord® ACTIVE

redcord® SPORT

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교육과정

Therapy and Rehabilitation

뉴렉 코스는 물리치료사, 의사, 자격증이 있는 운동 전문가 (해부,생리,역학에 대한 지식이 있는) 를 위한 과정입니다.

레드코드 뉴렉이란?

- 환자를 치료하기 위한 프로그램입니다.
- 통증이나 기능부전이 있는 환자에게 효과적입니다.
- 높은 수준의 근신경 자극으로 기능적인 움직임을 회복시킵니다.
- 뉴렉치료는 증상이 아닌 문제의 원인과 근육의 상호작용에 중점을 두고 치료합니다.
- 3개 이상의 축과 진동(vibration)을 사용하여 통증이 없는 상태를 만들고 치료를 진행합니다.

레드코드 뉴렉 교육과정

Neurac 1

- 3일 과정
- 총 21시간 (1일 7시간)
- Neurac 인트로
- 부위별 Neurac 접근법
- Local Motor와 Myofascial Chains 에 대한 Weaklink 검사 및 치료법

Neurac 2

- 6일 과정 , 3과목
- 총 42시간 (1일 7시간)
- Upper Extremity
- Lower Extremity
- Vibration
  - Neurac 차트 작성방법
  - Clinical Reasoning

Neurac 3

- 3일 과정
- 총 21시간 (1일 7시간)
- 환자와의 Communication
- Case별 그룹 컨퍼런스
- C.N.P가 되기 위한 Test

〈 Certified Neurac Practitioner 〉

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전문가 과정

C.N.P (Certified Neurac Practitioner)

뉴렉 인증 전문 치료사로, 모든 뉴렉 정규 코스를 이수한 전문가입니다.
뉴렉치료의 효과를 노르웨이 본부로부터 인증받은 치료사입니다.
전세계 120여명의 CNP가 활동하고 있으며, 한국에는 18명의 CNP가 있습니다

EURO		ASIA	
NORWAY	59	SOUTH KOREA	18
SWEDEN	9	TAIWAN	4
CZECH REPUBLIC	7	THAILAND	4
GERMANY	6	AMERICA	
ITALY	4	USA	14
NETHERLANDS	3	CANADA	2
SPAIN	2	PERU	1
BELGIUM	2		
UK	1		
LATVIA	1		
TURKEY	1		

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Wellness and Fitness

액티브 코스는 개인 트레이너, 필라테스 강사, 웰니스 및 피트니스 강사, 그룹트레이닝 강사를 위한 교육 과정입니다.

레드코드 액티브란?

- 환자를 뉴렉 치료 후 팔로우업 하는데 효과적인 프로그램입니다.
- 일반인의 웰니스를 위한 근신경계 활성화 프로그램입니다.
- 개별 트레이닝 또는 Small Group에 대한 프로그램이 있습니다.
- Redcord Movement Screen 테스트와 Myofascial Test에 근거한 개별 운동프로그램이 있습니다.
- Suspension , Rotation, Multisuspension Program이 있습니다.

레드코드 액티브 교육과정

Intro

- 2일 과정
- 총 14시간 (1일 7시간)
- 레드코드 개요
- Suspension 운동의 원리
- 운동사슬에 따른 슬링 접근법
- Multi-Suspension 접근법
- 회전운동의 원리

Advanced

- 2일 과정
- 총 14시간 (1일 7시간)
- 기능적 움직임 검사
  -Functional movement
  -Movement Screening
- 운동사슬 검사(Kinetic Chain Test)
- 교정 운동(Corrective Exercise)

Pro

- 2일 과정
- 총 14시간 (1일 7시간)
- 개별 운동 계획
- Case별 그룹 컨퍼런스
- RAS가 되기 위한 Test

〈 Redcord Active Specialist 〉

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전문가 과정

R.A.S (Redcord Active Specialist)

모든 액티브 정규 코스를 이수하신 국제적인 레드코드 액티브 전문가입니다.
전세계 50명, 국내 최초 RAS에 도전하세요!

EURO		ASIA	
NORWAY	6	TAIWAN	1
SWEDEN	2	THAILAND	4
NETHERLANDS	1	AMERICA	
SPAIN	2	USA	35
		MEXICO	3
		PERU	1

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레드코드 소개강좌

- 레드코드 개요 및 기본 원리 소개
- 근신경계 활성화를 위한 뉴렉 어프로치 소개
- 현장 환자 치료 데모 진행
- 뉴렉 치료가 궁금하신 모든 치료사 선생님들의 참가 가능

뉴렉 정기모임

- 뉴렉 강사님들의 노하우를 배우는 시간
- 평가, 치료, 운동까지 뉴렉의 전 과정을 경험하고 토의
- CNP의 케이스스터디
- 주제별 뉴렉 그룹스터디

레드코드 워크샵

- 슬링 이론과 Neurac 기본 컨셉
- 뉴렉의 Key point 레슨(이론+시연)
- 다양한 환자 케이스 적용, 치료 사례

12

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Kinetic chain of movement

- **열린사슬운동**

  Open Kinetic Chain

원위부의 체중 비부하.

개별근육 트레이닝 – 주동근

- **닫힌사슬운동**

  Closed Kinetic Chain

원위부의 **체중 부하**.

기능적인 트레이닝 – 주동근, 길항근, 협력근 동원

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Current Bobath Concept

is a **"problem-solving approach"** to the **assessment and treatment** of individuals with **disturbances of function**, **movement** and **postural control** ***due to a lesion of the CNS***, and can be applied **to individuals of *all ages*** and ***all degrees of physical and functional disability***.

(Raine 2006, IBITA 2007)

1. **과제를 주었을 때 보여지는 문제점을 해결하는 것.**
2. **Afferent input 을 제공하여 CNS가 문제해결하도록 이끄는 것**

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Current Bobath Practice

Relearning of "more efficient functional movement"

through manipulation of

a variety of "afferent inputs".

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THERAPY

To promote

"the efficiency of movement"

by developing the maximum potential an individual has,

not to achieve normal movement.

(Raine, 2002)

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Spasticity (Recent definition)

- **Disordered sensori-motor control**, resulting from an **UMN lesion**, **presenting** as **intermittent or sustained *involuntary activation of muscles***.

(SPASM, 2005)

Support **P**rogram for **A**ssembly of database for **S**pasticity **M**easurement (SPASM)

- It is **related to hypersensitivity of the reflex arc** *as a result of* ***the loss of descending facilitation***.

(Ivanhoe C.B.)

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Associated Reactions

- "***released postural reactions*** **in muscles deprived of voluntary control**".

first described by Walshe in 1923

- **"Weakness"** is **always underlying the presentation of ARs.**
  - ***Pathological from of postural fixation***.
  - **Indicator of the patient's efficiency of motor control**, ***effort*** *or* ***complexity of movement*** *or anxiety.*
  - **Trunk control rather than inhibit ARs.**

(Lynch 2000)

➔ **Trunk control, postural control, antigravity**

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Acute phase
(Rehabilitation phase I)

Growth-associated protein (GAP-43) : 손상된 신경 재생 시 axonal growth를 확인할 수 있는 가장 널리 알려진 단백질

Neurophysiological:

The brain's plasticity:

GAP 43

Collateral sprouting

Neuromuscular:

***Hypo*-tonic muscles**

Compensation

Neuropsychological outcomes.

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The stroke patient
(Acute phase)

- Start rehabilitation early
- **Re-learning**
- **Guiding**
- **Prevent compensation**
- **Strength and tension grading**
- **Adapted balance training**

→ **Prevent associated reactions**

- Gain overview of neuropsychological outcomes
- **Support to avoid associated reactions**

Open Kinetic Chain ex.

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Rehabilitation phase II

Neurophysiological:

The brain's plasticity:

↓**GAP 43**

↓**Collateral sprouting**

Neuromuscular:

***Hyper*-tonic / *hypo*-tonic musculature**

Associated reactions

Spasticity

Compensation

Neuropsychological outcomes:

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The stroke patient

(Rehabilitation phase II)

- **Sensori-motor training = functional training**
- **Closed kinetic chain training**
- **Stability and balance**
- **Transfer of weight** — **From OKC to CKC**
- **Progression**
- **Associated reactions**
- **Variation**
- **Good transfer effect ("carry over ")**
- **Training on their own**
- **Motivation and joy of *training***
- **Other family members can use the equipment**

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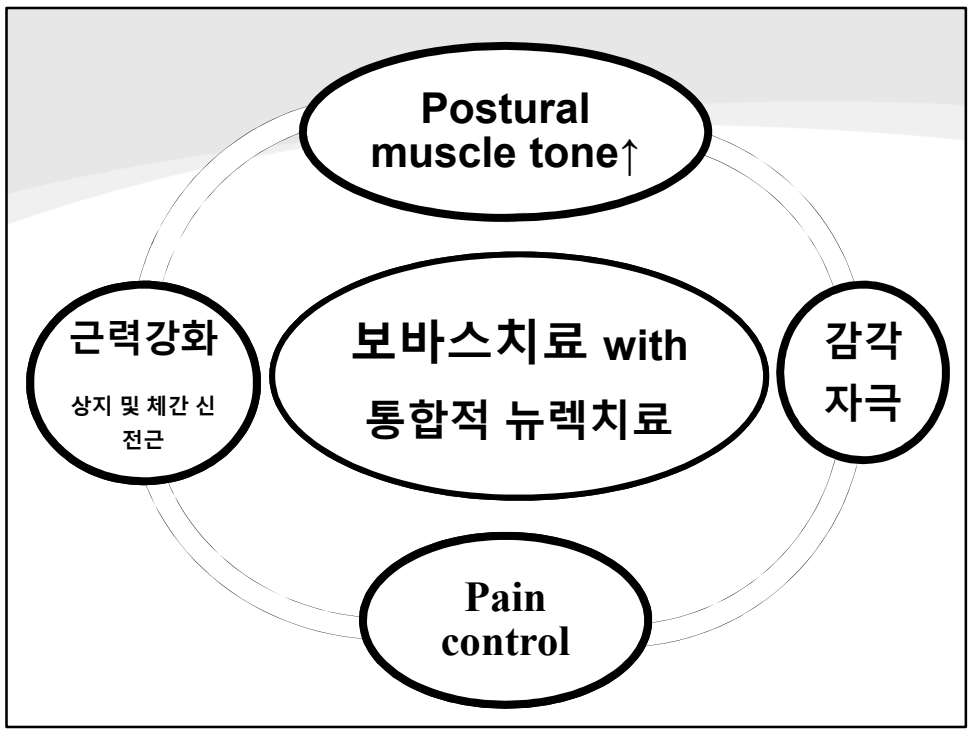
Postural muscle tone↑
근력강화
상지 및 체간 신전근
보바스치료 with 통합적 뉴렉치료
감각 자극
Pain control

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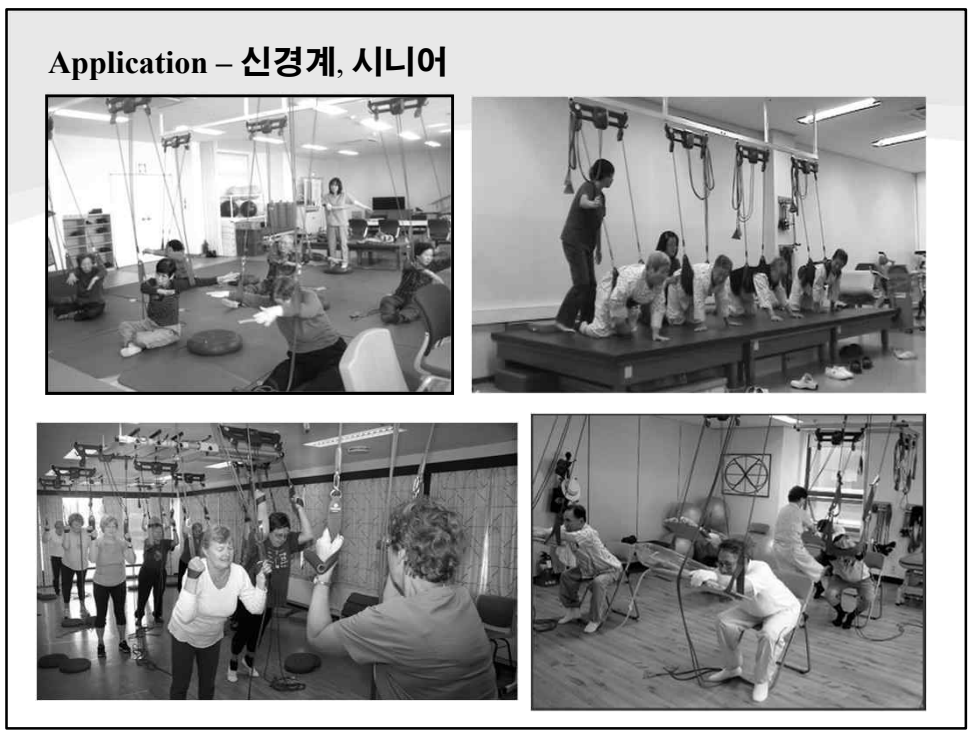
Application – 신경계, 시니어

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노르웨이 슬링운동센터

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Placement of the sling

Placement of the sling *varies* ***according to the treatment*** *or* ***the exercise purpose***

With pain and instability, suspension close to joint *and* ***vertical pull are necessary***

CNS pt's ➔ Use neutral suspension

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TREATMENT and TRAINING in a LATERAL POSITION

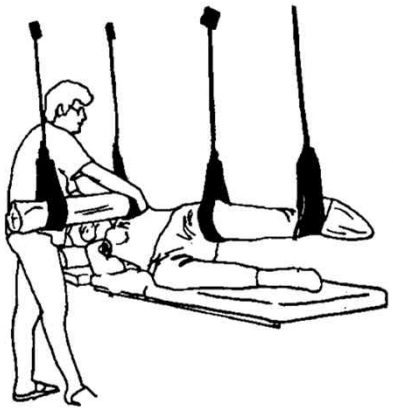
TRUNK-SHOULDER-ARM

SUSPENSION POINT AND SLING PLACEMENT:

Suspension point directly above the patient's arm. Neutral suspension.
Place the proximal sling all the way into axilla, so that the caput humeri is centered.
Strap or sling distally.

Vary the suspension point as needed.
Find a pain-free initial position

Use splints as needed.



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Why is the TerapiMaster a <u>suitable tool in stroke rehabilitation</u> in the acute stage (Rehabilitation stage 1) ?

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SWINGING THE AFFECTED ARM

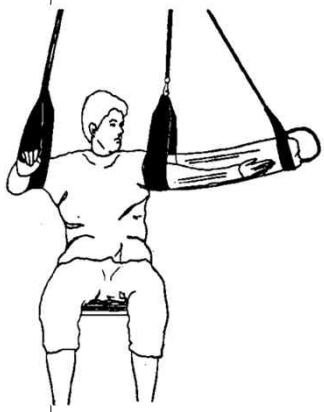
SUSPENSION POINT AND SLING PLACEMENT:
Directly above the proximal sling.
Sling on the upper arm and/or the elbow, hand in a strap.

EXECUTION:
Pull the arm to the height at which the patient has activity.
Although both arms can be suspended, in cases of left-side paralysis with hemianopsia and neglect, often only the right arm will be swung.
Use splints as needed.
Perform swinging movements and protraction

GOALS:
Pleasure in incipient movement.

Making the patient aware of the affected arm.

Sensorimotor training.
Increasing circulation.



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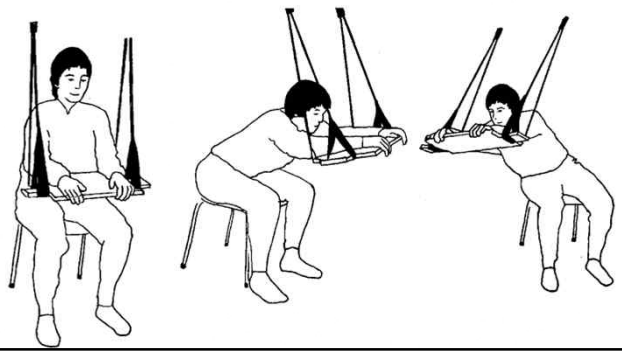
SEATED ON A CHAIR/BENCH

Choose a seat according to the patient's level.
SUSPENSION POINT:
Above the middle of the patient's forearms. Wide special board, wide board, swing board or pelvic/back sling.
EXECUTION:
Both arms on the board/sling. The patient moves the board/sling forward and to the sides.
VARIATION:
Regulate the height of the suspension. **Note:** Shoulder pain is not tolerated.



GOALS:
- Learning and understanding bending the hip.
- Stretch and rotation of the trunk.
- Movement of the shoulder.
- Weight bearing on the affected side.
- Balance training.
- Inhibiting spasms.

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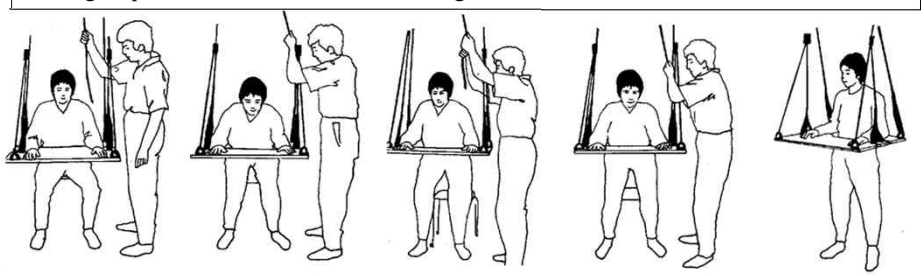
STANDING UP - *Assisted by a board*

SUSPENSION POINT:
Directly in front of the patient's knees
SLING PLACEMENT:
Fasten the straps to the hooks in the middle of the board
Secure using a rope at the front and/or back of the board
1) The patient begins by moving his/her feet back
2) The patient brings his/her upper body forward, far enough so that his/her legs take the weight
3) Continue to rise to a standing position. The therapist pulls the middle ropes so that the board follows the patient's movement. The board provides security; the patient feels he/she is being helped and will dare to lean far enough forward.



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The Task of Postural Control

'Controlling the body's position in space

for the **dual purposes** of

"stability" and "orientation"

Shumway-Cook and Woollacott 1995

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“Seated position of readiness” for function

- Pelvic is in neutral to anterior tilt
- Equal W/B *on both ischial tuberosities*
- Trunk erect and midline with appropriate spinal curves
- Shoulders symmetrical and over the hips
- Head/neck neutral
- Hips slightly above the level of the knees
- Knees in line with the hips
- Feet equally W/B and underneath the knees

Gillen’s stroke Rehabilitation, 2010

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체간의 기능적 움직임을 위한 static neutral position of CORE

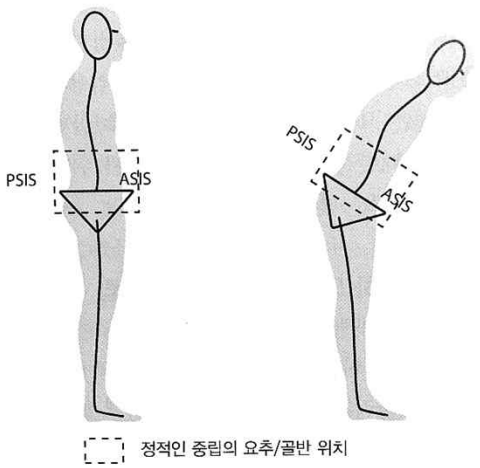

그림 12.2 바로 서 있을 때의 중립 요추/골반 유닛(a), 그리고 전방으로 기울인 자세(b). PSIS, 후상장골극; ASIS, 전상장골극

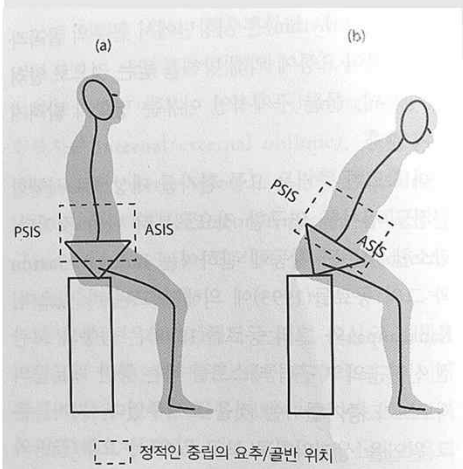

그림 12.6 (a)상체를 바로 세우고 높은 의자에 앉은 자세와 (b)전방으로 기울인 자세에서의 중립적인 요추/골반 유닛. PSIS, 후상장골극; ASIS, 전상장골극

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Optimal Postural Set

1. **충분한 antigravity activity**, ground reaction
2. **"Eccentric lengthening"**
   a. **Righting reaction ➔ Anti-gravity** 방향으로 **upright & tonic activity 극대화**
   b. 가장 강력한 proprioceptive input
3. **Weight transfer re-training**
   a. Head의 움직임은 최소화
   b. Ventromedial system이 먼저 upright 방향으로 firing
   c. Dorsolateral system의 movement 가능해짐

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SEAT LIFT

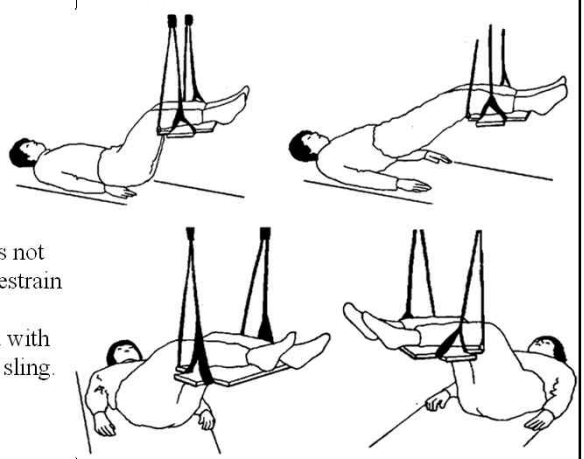
LEGS ON AN EXERCISE BOARD, BENCH OR THE FLOOR

SUSPENSION POINT:
Over the middle of the board.
Place the calves on the board.
The height can vary; a high board makes lifting easier.

EXECUTION:
- Lateral flexion of the trunk.
- Easy rotation of the pelvis.
- Seat lift.

Make sure that the effected leg does not become spastic. The therapist can restrain the leg, or a splint can be used.
The exercise can also be performed with slings and straps or the back/pelvic sling.

GOALS:
- Seat lift, the feeling of lifting the affected side.
- Resting position for a tense back.



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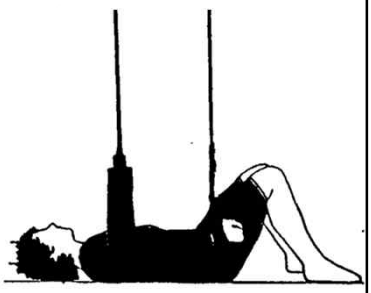
TREATMENT AND TRAINING IN SUPINE POSITION,

SHOULDER - ARM

SUSPENSION POINT AND SLING PLACEMENT:

Suspension point directly above and along the arm.
Sling on the upper arm proximally, near the axilla, hand in the strap.
An extra sling under the elbow, if needed.



Use splints as needed.

Resting position with a long arm splint, the splint can be on for up to an hour, but should be removed in case of discomfort or pain.

Make sure that the leg is well positioned.

Secure the legs according to need/level:

Psoas cushion, wide board, slings on both legs, or slings on one leg.

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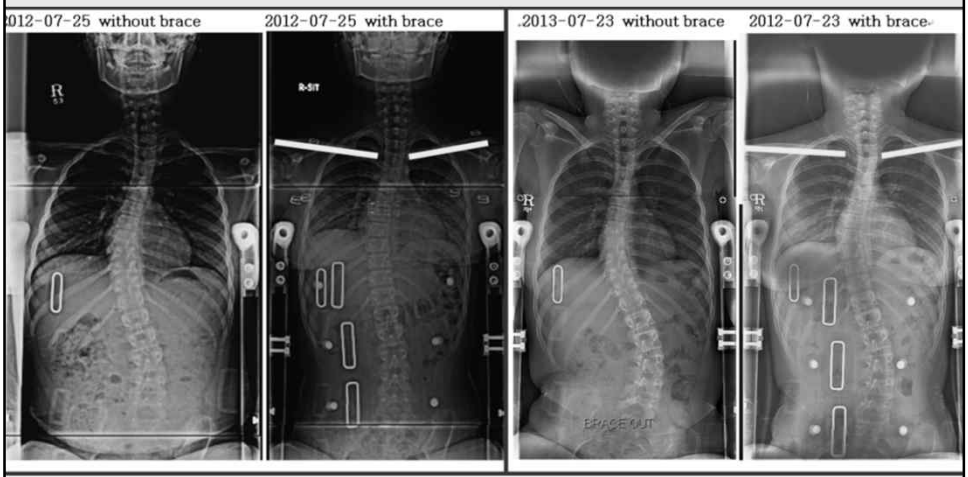

Scoliosis < 2011.1.14 > 2012.7.26 > sitting c brace >13.7.23
Rt. thoracolumbar T7-L1 apex T9, Cobb's angle: 26.1도 > T4-L1, apex T9, Cobb's: 37.5도> T4-L1, apex T9, Cobb's: 27.5도 > 24.3도
Lt. lumbar L1-L5 apex L3, Cobb's angle: 23도 > L1-L5, apex L3, Cobb's: 22도> L1-L5, apex L3, Cobb's: 25.2도>21도

Scoliosis < 2011.1.14 > 2012.7.26 > Supine
Rt. thoracolumbar T7-L1 apex T9, Cobb's angle: 9.2도 > T4-L1, apex T9, Cobb's: 24.5도>25.8도
Lt. lumbar L1-L5 apex L3, Cobb's angle: 6.3도 > L1-L5, apex L3, Cobb's: 12.3도>19.7도
sitting s brace
T4-T12 27.3 > 29.3
L1-L5, apex L3, Cobb's : 31>37도

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The Intensity of the Exercises

was **increased** by introducing one or several of the following changes:

(1) reducing *the Base of support*
(2) increasing *the Lever Arm*
(3) advancing *the Balance Limits*
(4) increasing *the Hold Time*

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CASE 1. Modified Neurac Tx.

- **척수손상: Spinal Cord Injury**
  - **Complete Tetraplegia, C4/C4(s) AIS-A**

- **환자의 목표 :**
  1. **내가 움직이고 싶을 때, 움직이고 싶어요.**
  2. **바람이 내 코를 간지럽히면, 바람을 등지고 피하고 싶다.**
  3. **봄이 되면, 날아다니는 나비를 따라서 그냥 움직이고 싶다.**

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Problem lists

- 손상 이하의 poor postural muscle tone
  - LE muscle tone은 MAS로 체크되지 않음
  - Niddle EMG 상에서 motor unit check 되지 않으나, OKC 상에서 움직임 관찰됨
  - Position change 즉 hip extension 될 때, knee extensors spasm 관찰됨(1➔4초 지속). 간헐적으로 LE flexors spasm도 관찰됨(1초 지속).
- Decreased somatosensory input
- 치료에 참여하는 지구력 부족(호전되고 있음)

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Therapeutic exercises

- Neck muscles strengthening : Red-cord sling
  1. Deep cervical flexor
  2. Cervical setting exercises
  3. Automatic W/C controlling (reclined, standing etc.)
- Neuro-muscular reeducation
  1. Key muscles – sitting balance
  2. Trunk muscles for - upright sitting

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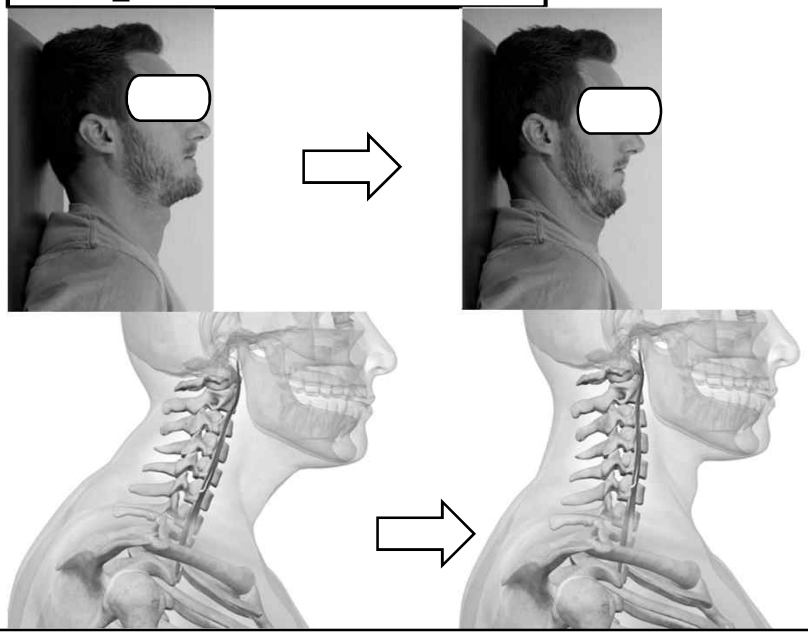
Deep cervical flexor



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Ambulation

- **Automatic W/C controlling (reclined, standing etc.)**
- **Using deep cervical flexors, and neck extensors**

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Ambulation using neck muscles

- Automatic W/C controlling (reclined, standing etc.)
- Using deep cervical flexors, and neck extensors, neck rotators

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redcord

CASES. Modified Neurac Tx.

- 척수손상: Spinal Cord Injury
  - Complete Paraplegia, T6/T6(s) AIS-A
  - Complete Paraplegia, T8/T8(s) AIS-A
  - Incomplete Tetraplegia, C6/C6(s) AIS-C
  - Incomplete Tetraplegia, C3/C4(s) AIS-C
  - Incomplete Tetraplegia, C5/C5(s) AIS-C
  - Incomplete Paraplegia, T12/T12(s) AIS-D

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“흉수손상환자: 제가 혼자 앉을 수는 있을까요?”

POD 51일, **욕창치료 종결 후 재활의학과로 전과**되어 **처음 재활치료실에 내려가는 날 아침**. 환자와의 면담.

"얼마만에 앉는건지 모르겠어요.
침대에 기대어 앉아있는데도 몸이 휘청거리는것 같고, 내가 똑바로 앉은건지, 옆으로 넘어지고 있는건지도 잘 모르겠어요.
이렇게 기대어 앉는 것도 힘든데...
앞으로 두 발로 걷지 못한다 하더라도, 등받이 없이 혼자 앉을 수는 있을까요?"

환자가 자신의 신체상태를 대략적으로 인지함.

초기 평가시 환자의 목표

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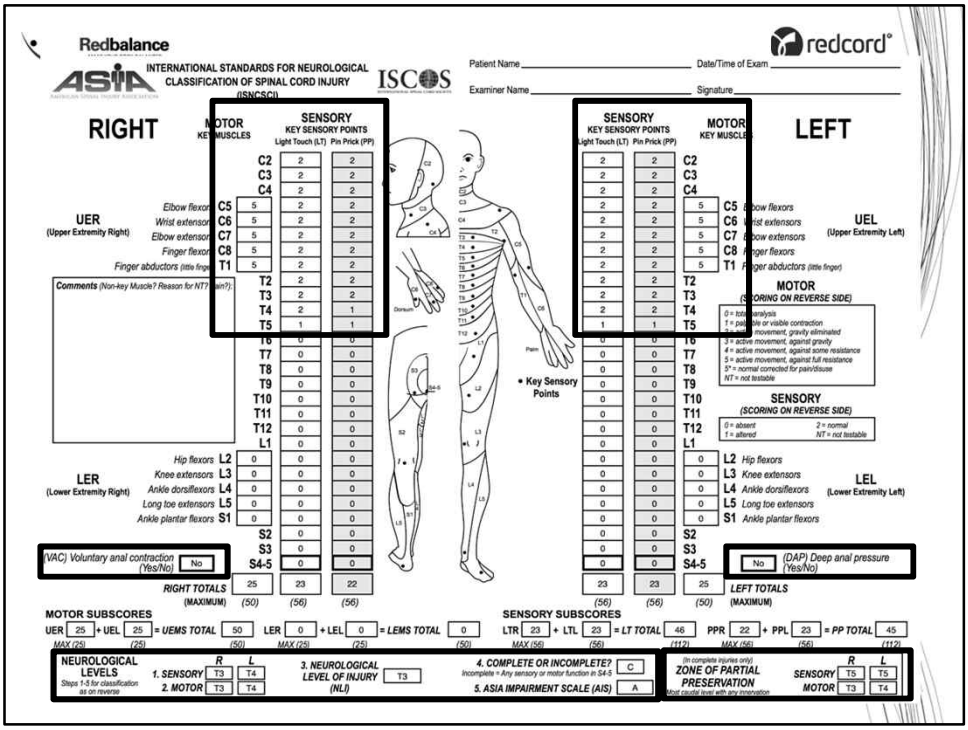

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Problem lists

- 손상 이하의 poor postural muscle tone
  - LE muscle tone은 MAS로 체크되지 않음
  - Position change 즉 hip extension 될 때,
    knee extensors spasm 관찰됨(1➔4초 지속).
    간헐적으로 LE flexors spasm도 관찰됨(1초 지속).
- Decreased somatosensory input
- 치료에 참여하는 지구력 부족(호전되고 있음)
- Associated injury
  - Multiple rib Fx. & hemo-pneumothorax
    ➔➔ Vital capacity decrease

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Therapeutic goal setting

- 초기 입원환자 : Brace 착용하고 sitting balance training ???
  ➔➔ isometric and core training 우선적 치료
- Brace off 를 준비하기 위한 Ex.
  - Isometric ex. with sling for Scapular m. setting
  - Strengthening ex. : Trunk extensors, Shoulder, Core
  - Neuromuscular reeducation with visual feedback
- Sitting postural endurance 증진
  - To build muscle tone ➔➔ FES
  - Core stability training with trunk upright maintain
    ➔➔ lower trunk 와 pelvis의 relationship 증진
- Lung Volume increase
  - ➔ Chest wall compliance 증진 (Air stacking ex.)
- Standing program

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FES response (knee extensors 55/55 ➔ 50/50mA)

Type 1(tonic) m. ➔SCI➔ Type 2(phasic) m.
➔**FES apply**➔➔ Type 1(tonic) m.

초기평가시 15분 후 fatigue 발생➔ 5mA 상향 조절 후 muscle contraction 및 full ROM.
2014-03-07부터 : fatigue 보이지 않으며 both side 5/5mA 하향한 50/50mA로 20분간 muscle contraction 및 full ROM 보이심.

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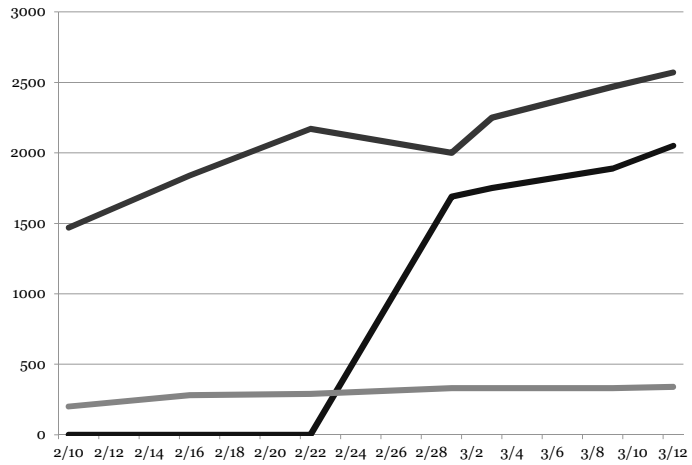
PTx. Lung Volume increase



MIC
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	02월 10일	02월 16일	02월 22일	03월 01일	03월 03일	03월 09일	03월 12일	D/C
FVC supine without brace	1470 (39%)	1840	2170	2000	2250	2470	2570 (68%)	3680
FVC sitting with brace	UC (sore)	UC	UC	1690	1750	1890	2050	3550
PCF with brace	200	280	290	330	330	330	340	390

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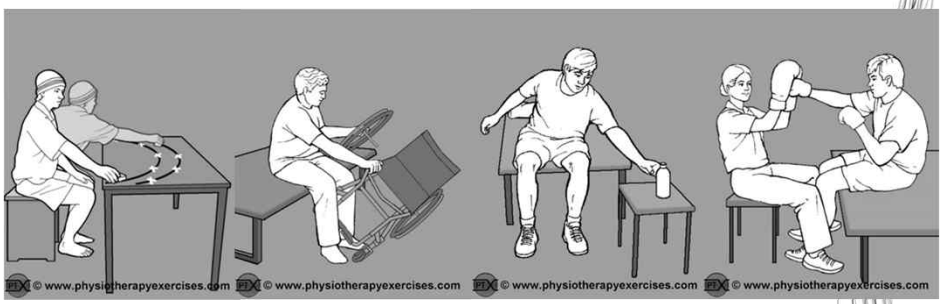
Brace off 이후의 PTx.

- **Start Functional training**
  1. **Rolling**
  2. **Moving from supine to long sitting**
  3. **Unsupported sitting**
  4. **Lifting vertically**
  5. **Transferring - horizontal transfer**
- **Sitting balance training**
  - **Open kinetic chain ex.**
  - **Close kinetic chain ex.**

3. Unsupported sitting – Ex.

- Any of these exercises will help a person with **motor complete T4 paraplegia *learn strategies* to sit unsupported.**



ISCOS e-learning SCI, 2013