Post CVA neurological stiffness

Petros Mikalef
Consultant Hand Surgeon
Southampton NHS Treatment Centre
• Stiffness

• CVA

• CVA to stiffness

• Treatment

• Take Home message
• Stiffness

• CVA

• CVA to stiffness

• Treatment

• Take Home message
What is Stiffness?

• Stiffness
  • ...the rigidity of an object — the extent to which it resists deformation in response to an applied force.
  • ...the complementary concept is flexibility or pliability: the more flexible an object is, the less stiff it is.
What is Stiffness?

- Stiffness: a term used to describe **the force needed to achieve a certain deformation of a structure.**

- “Stiffness” = “Load” divided by “Deformation”,

\[ \text{Stiffness} = \frac{\text{Load}}{\text{Deformation}} \]

- Can be a force, a moment, a stress or a combination of some of these physical variables acting on the structure.

- The actual geometrical configuration of the elastic structure is different from the original “unloaded” reference configuration.

- Is always a comparison of two different configurations of a structure.

What is Stiffness?

- **Joint Stiffness**
  - pain and discomfort in a joint, causing difficulty in movement
  - can result from medical conditions such as arthritis or from injury, especially when there is protective spasm of the surrounding muscles.
  - unexplained joint stiffness requires medical assessment and investigation.
What is Stiffness?

- Stiffness can be defined as limited ROM that affects a patient’s ability to perform activities of daily living

• Stiffness
• CVA
• CVA to stiffness
• Treatment
• Take Home message
What is a CVA?

Stroke, Cerebrovascular accident

• A stroke is caused by the interruption of the blood supply to the brain, usually because a blood vessel bursts or is blocked by a clot. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue.
Central nervous system infarction

...brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury

• Can be:
  • **ischemic stroke** specifically refers to central nervous system infarction accompanied by overt symptoms
  • **silent infarction** by definition causes no known symptoms
  • ...also broadly includes **intracerebral haemorrhage** and **subarachnoid haemorrhage**
• Stiffness

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• CVA to stiffness

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Recovery

• **Spontaneous or Intrinsic Neurological Recovery**
  
  • recovery of neurological impairments
  
  • is often the result of brain recovery/reorganization
  
  • it has been increasingly recognized as being influenced by rehabilitation

• **Functional or Adaptive Recovery**

  • improvement in mobility and activities of daily living
  
  • it has long been known that it is influenced by rehabilitation
Upper Motor Neuron Lesion

• ...a lesion of the neural pathway above the anterior horn cell of the spinal cord or motor nuclei of the cranial nerves

Upper Motor Neuron Syndrome

• ...the change in motor control that occurs after an upper motor neuron injury

• Characteristics...
  ...the presence of spasticity and other forms of involuntary muscle overactivity, voluntary weakness, and a variety of motor control abnormalities that impair the regulation of voluntary movement
### Upper Motor Neuron Syndrome

<table>
<thead>
<tr>
<th>Positive signs</th>
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<tbody>
<tr>
<td>Increased tendon reflexes</td>
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</tr>
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<td>Series of involuntarily, rhythmic, muscular contractions and relaxations due to a self re-excitation of hyperactive stretch reflexes in the affected muscle</td>
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<td>Positive Babinski sign</td>
<td>Extension of the big toe, while the other toes fan outwardly in response to rubbing of the sole of the foot. It indicates a lesion of the corticospinal tract</td>
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<tr>
<td>Spasticity</td>
<td>Muscle hypertonia during movement (active or passive), dependent upon velocity of muscle stretch</td>
</tr>
<tr>
<td>Extensor/flexor spasms</td>
<td>Spasms occur spontaneously or in response to stimulation (movement of the leg, change of position). The most common pattern of flexor spasm is flexion of the hip, knee and ankle</td>
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<tr>
<td>Spastic co-contraction (during movement)</td>
<td>Agonist and antagonist muscles co-contract simultaneously inappropriately and thus disrupt normal limb movement. This is due to the perturbation of the spinal reflexes that contribute to reciprocal innervation</td>
</tr>
<tr>
<td>Associated reactions and other dyssynergic stereotypical spastic dystonia</td>
<td>Remote form of synkinesis due to a failure to inhibit spread of motor activity (e.g. flexion of the elbow simultaneously to flexion of the hip during walking)</td>
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# Upper Motor Neuron Syndrome

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<tr>
<td>Muscle weakness</td>
<td>Muscles have lower strength due to the loss of corticospinal drive</td>
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<tr>
<td>Loss of dexterity</td>
<td>Loss of hand precise movements, such as opposition of the thumb due to a weakness of the intrinsic and extrinsic hand muscles</td>
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<tr>
<td>Fatigability</td>
<td>Greater effort required to perform a movement leading to tiredness</td>
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**Spasticity**

- **Muscle hypertonia during movement (active or passive), dependent upon velocity of muscle stretch**

| Extensor/flexor spasms              | Spasms occur spontaneously or in response to stimulation (movement of the leg, change of position). The most common pattern of flexor spasm is flexion of the hip, knee and ankle |
| Spastic co-contraction (during movement) | Agonist and antagonist muscles co-contract simultaneously inappropriately and thus disrupt normal limb movement. This is due to the perturbation of the spinal reflexes that contribute to reciprocal innervation |

| Associated reactions and other dyssynergic stereotypical spastic dystonia | Remote form of synkineses due to a failure to inhibit spread of motor activity (e.g. flexion of the elbow simultaneously to flexion of the hip during walking) |
Spasticity

• ‘...a motor disorder characterized by a velocity dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron syndrome’


• Clinically spasticity manifests as:
  • ...an increased resistance offered by muscles to passive stretching (lengthening)
  • ...is often associated with other commonly observed phenomenon like clasp-knife phenomenon, increased tendon reflexes, clonus, and flexor and extensor spasms

Mukherjee A, Chakravarty A. Spasticity mechanisms - for the clinician. Front Neurol. 2010 Dec 17;1:149
• **Spasticity**
  
  • ...disordered sensorimotor control
    
    presenting as *intermittent or sustained involuntary activation of muscles’*
  
  • ...it is a frequent symptom of common neurological disorders
    
    *multiple sclerosis* and *stroke*
  
  • ...Spasticity varies from
    
    a clinical sign with no functional impact
    
    a gross increase in tone interfering with mobility, transfers and personal care.
  
  • ...untreated, it can cause shortening of muscles and tendons, leading to contractures
  
  • ...some patients depend on their spasticity to stand, walk and transfer or sit upright
• **Features of Spasticity**

  • **Increased tone**
  
  • **Clonus**
    • is the phenomenon of involuntary rhythmic contractions in response to sudden sustained stretch.

  • **Spasms**
    • are sudden involuntary movements that often involve multiple muscle groups and joints.

  • **Spastic dystonia**
    • is tonic muscle overactivity that occurs without any triggers.
    • Spastic dystonia can lead to contractures and deformities causing pain, discomfort and high-care needs.

  • **Spastic co-contraction**
    • is the inappropriate activation of antagonistic muscles during voluntary activity.
    • It is *due to loss of reciprocal inhibition* during voluntary contraction. In spastic co-contraction, there are instead **mass contractions of both agonist and antagonistic muscles, resulting in loss of dexterity and slowed movements**.
• Characteristic Features of Spasticity

  • **Velocity dependence**
    • The increased tone of spasticity is velocity dependent, that is, the faster the stretch, the greater the muscle resistance

  • **‘Clasp-knife’ phenomenon:**
    • This is where the spastic limb initially resists movement and then suddenly gives way, rather like the resistance of a folding knife blade
    • On sustained movement, the inverse stretch reflex kicks in, relaxing the muscles with a ‘give away’ feel
    • In the later stage, as contractures set in, this is replaced by a non-elastic solid resistance

  • **Stroking effect**
    • Stroking the surface of the antagonistic muscle may reduce the tone in spasticity, though it does not affect contracture

  • **Distribution**
    • Spasticity has a differential distribution with antigravity muscles being more affected.
• **Spasticity**

• .....deregulation of the motor pathways (mainly the corticospinal, reticulospinal, and the vestibulospinal tracts) running from the cerebral cortex and brain stem to the spinal cord

• Instead, damage to tracts that interact with the corticospinal tract is thought to contribute to spasticity.

  • For example, damage along the reticulospinal tract decreases its inhibitory influence, resulting in *increased muscle tone* [15]

  • Loss of *vestibulospinal tract* excitation by the cortex is thought to cause decreased firing of the motor neurons, resulting in *decreased extensor tone* and thus a flexed posture
Extensors

Flexors

Extensors

Spastic and/or Contracted Flexors

Shoulder Adduction and Internal Rotation

Elbow Flexion

Forearm Pronation

Wrist Flexion

Finger Flexion (Clenched fist with Thumb-in-Palm Deformity)
• Annually, 15 million people worldwide have a stroke (15,000,000)
• Five million die (5,000,000)
• 5 million are left permanently disabled (5,000,000)
  • Complications:
    • Motor impairments (50–83%) (2,500,000 – 4,150,000)
    • Cognitive Impairments (50%) (2,500,000)
    • Language impairments (23–36%) (1,150,000 – 1,800,000)
    • poststroke seizures (10%) (500,000)
    • neuropathic pain (8%) (400,000)
    • Psychological disturbances (20%) (1,000,000)
• 33–42% of patients still require assistance for ADLs 3 – 6 years poststroke (1,650,000 – 2,100,000)
• 36% of patients remain disabled after five-years (1,800,000)

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• Stroke and its subsequent disabilities place a large burden on the family and community

• ...2–4% of total health care costs globally
  • ...lifetime cost estimated at US$1 40 048 in the United States and 43 129 in Europe
• Even among those deemed ‘recovered’ from stroke based on a Barthel index score of >95, they still can have difficulties with

  • hand function
  • dependence in daily activities
  • impaired overall physical function
  • limitations of social participation

  ....all of which may impair quality of life
• 460 post Stroke patients

• **Spasticity**
  
  • ...negative impact on the HRQoL (health-related quality of life) of stroke survivors
  
  • ...statistically and clinically meaningful differences existing between stroke survivors with and without spasticity

• These results suggest an opportunity to improve HRQoL among stroke survivors with spasticity.

Factors aggravating spasticity

- Pressure ulcers
- Ingrown toenails
- Skin infections
- Injuries
- Constipation
- Urinary tract infection
- Urinary tract calculi
- Deep vein thrombosis
- Improper seating
- Ill-fitting orthotics
- Post-traumatic syringomyelia
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| **Adducted/internally rotated shoulder** | Pectoralis major, Teres major, Latissimus dorsi, Anterior deltoid, Subscapularis, Teres major, Latissimus dorsi, Long head of triceps, Posterior deltoid | ✓ Muscle contractures and pain  
✓ Shoulder stiffness and painful passive range of motion  
✓ Skin maceration, breakdown and malodor in the axilla  
✓ Difficulties for dressing  
✓ Limitation of the reaching-forward behaviour |
| **Flexed elbow**                | Biceps, Brachialis, Brachioradialis                   | ✓ Muscle contractures and pain  
✓ Persistent elbow flexion during sitting, standing and walking  
✓ Difficulties for transfer (no fulcrum), dressing and reaching objects  
✓ Skin maceration, breakdown and malodor in the antecubital fossa  
✓ Disfiguring appearance  
✓ Stretch injury to the ulnar nerve (at the bend of the elbow)  
✓ The nerve is vulnerable to repeated trauma and can be compressed in the cubital tunnel leading to intrinsic muscle atrophy in the hand and weakness of ulnar wrist and finger flexion |
| **Pronated forearm**            | Pronator teres, Pronator quadratus                    | ✓ Muscle contractures and pain  
✓ Difficulties to reach underhand to a target  
✓ Limitations to turn the patient’s hand palm side up for fingernail trimming (important for patients with fingers that are flexed into the palm secondary to a clenched fist deformity)  
✓ Difficulties to feed (e.g., hold a spoon) |
| **Flexed wrist**                | Flexor carpi radialis, Flexor carpi ulnaris, Palmaris longus, Extensor carpi ulnaris | ✓ Muscle contractures and pain  
✓ Compression of the median nerve at wrist with carpal tunnel syndrome and hand pain  
✓ Disfiguring appearance  
✓ Awkward hand placement during reaching and impairs positioning of objects held  
✓ Weakened grip strength |
| **Clenched fist**               | Flexor digitorum sublimis and profundus               | ✓ Patients cannot perform the reach phase to grasp an object  
✓ Fingernails digging into palmar skin with pain  
✓ Nail bed infections  
✓ Pain when somebody attempts to pry fingers open to gain palmar access  
✓ Disfiguring appearance  
✓ Skin maceration, breakdown and malodour in the palm  
✓ Difficulties to wear gloves or hand splints  
✓ Limitation for grasping, manipulation and release of objects  
✓ Development of muscle, skin and joint contractures |
| **Thumb-in-palm deformity**     | Flexor pollicis longus and brevis, Adductor pollicis, First dorsal interosseous | ✓ Difficulties to wear gloves or hand splints  
✓ Limitation of thumb extension and abduction that open up the web space before grasp  
✓ Difficulties to execute grasp patterns (three-jaw chuck, lateral grasp and tip pinch) |
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|                     | Palmaris longus                                |                                                                                                                                              |
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Assessing the patient
Spasticity

- Functional Upper Limb
- Non functional Upper Limb
• Muscle Contracture
• Joint Contracture
• Motor assessment
  ✓ Active muscles
  ✓ Paralyzed muscles
• Sensory assessment
• Functional assessment
  ✓ Functional Tests
    ➢ AHA (Assisting Hand Assessment)
    ➢ The pick-up and release test
    ➢ The box and Block test
    ➢ Bimanual Activities
  ✓ Questionnaires

• General Assessment
  ✓ Other neurologic impairments
    ➢ Athetosis
    ➢ Chorea
    ➢ Parkinsons
  ✓ Age
  ✓ Motivation and environment
  ✓ X-rays
  ✓ EMG
    ✓ muscles can be utilized for tendon transfer only if they are capable of relaxation at rest or during the antagonist movement (phasic control).

Trophic changes, such as reflex sympathetic dystrophy and vaso-motor changes, are frequently associated – contraindication for surgery
Better clinical outcomes have been noted when postacute stroke patients receive coordinated, multidisciplinary intervention involving

- Physician
- Nurse
- Physical therapist
- Occupational therapist
- Kinesiotherapist
- Speech and language pathologist
- Psychologist
- Recreational therapist
- Family/caregivers

Individualized treatment
Spasticity

Modified Tardieu Scale

X: Quality of movement mobilization

0  No resistance throughout the course of the passive movement
1  Slight resistance throughout the course of passive movement, no clear catch at a precise angle
2  Clear catch at a precise angle, interrupting the passive movement, followed by release
3  Fatigable clonus with less than 10 seconds when maintaining the pressure and appearing at the precise angle
4  Unfatigable clonus with more than 10 seconds when maintaining the pressure and appearing at a precise angle
5  Joint is fixed

V: Measurements take place at three different velocities

V1  As slow as possible
V2  Speed of limb segment falling under gravity
V3  As fast as possible

Y:  Angle of catching (muscle reaction)
Spasticity

Modified Ashworth scale

X: Quality of movement mobilization

0  No increase in muscle tone
1  Slight increase in muscle tone
1+ Slight increase in muscle resistance throughout the range
2  Moderate increase in muscle tone throughout the range of motion; passive movement is easy
3  Marked increase in muscle tone throughout the range of motion; passive movement is difficult
4  Marked increase in muscle tone; affected part is rigid
## Spasticity

### House’s Functional Classification System

<table>
<thead>
<tr>
<th>Class</th>
<th>Designation</th>
<th>Activity level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Does not use</td>
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</tr>
<tr>
<td>1</td>
<td>Poor passive assist</td>
<td>Uses as stabilizing weight only</td>
</tr>
<tr>
<td>2</td>
<td>Fair passive assist</td>
<td>Can hold onto object placed in hand</td>
</tr>
<tr>
<td>3</td>
<td>Good passive assist</td>
<td>Can hold onto object and stabilize it for use by other hand</td>
</tr>
<tr>
<td>4</td>
<td>Poor active assist</td>
<td>Can actively grasp object and hold it weakly</td>
</tr>
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<td>5</td>
<td>Fair active assist</td>
<td>Can actively grasp object and stabilize it well</td>
</tr>
<tr>
<td>6</td>
<td>Good active assist</td>
<td>Can actively grasp object and then manipulate it against other hand</td>
</tr>
<tr>
<td>7</td>
<td>Spontaneous use</td>
<td>Can perform bimanual activities easily and occasionally uses the hand spontaneously</td>
</tr>
<tr>
<td>8</td>
<td>Spontaneous use</td>
<td>Uses hand completely independently without reference to the other hand</td>
</tr>
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Stiffness after CVA

• Neurologic contractures
  • Spasticity
  • Spastic Dystonia
  • Spastic co-contracture

• Muscle contracture

• Joint Contracture
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• **Velocity dependence**
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• Characteristic Features of Spasticity

• **Velocity dependence**
  • The increased tone of spasticity is velocity dependent, that is, the faster the stretch, the greater the muscle resistance

• **‘Clasp-knife’ phenomenon:**
  • This is where the spastic limb initially resists movement and then suddenly gives way, rather like the resistance of a folding knife blade
  • On sustained movement, the inverse stretch reflex kicks in, relaxing the muscles with a ‘give away’ feel
  • In the later stage, as contractures set in, this is replaced by a non-elastic solid resistance

• **Stroking effect**
  • Stroking the surface of the antagonistic muscle may reduce the tone in spasticity, though it does not affect contracture

• **Distribution**
  • Spasticity has a differential distribution with antigravity muscles being more affected.
Spasticity + muscle contracture + joint contracture

Courtesy to Mme Caroline Leclercq, Institut De La Main, Paris
Muscle lengthening (biceps + BR)

Remaining joint contracture

Courtesy to Mme Caroline Leclercq, Institut De La Main, Paris
Nonoperative Treatments

• Medication
• Physical Therapy/Occupational Therapy
• Chemodenervation
  • Botulinum Toxin
  • Phenol

Operative Treatments
<table>
<thead>
<tr>
<th>Drugs</th>
<th>Action</th>
<th>Major Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baclofen</strong></td>
<td>Reduces release of excitatory neurotransmitters and Substance P in the spinal cord  &lt;br&gt; Decreases post synaptic effect of excitatory neurotransmitters</td>
<td>Sedation  &lt;br&gt; Weakness  &lt;br&gt; Seizures  &lt;br&gt; Hallucinations</td>
</tr>
<tr>
<td><strong>Tizanidine</strong></td>
<td>Reduces release of excitatory neurotransmitters and Substance P in the spinal cord  &lt;br&gt; Decreases neuronal firing in locus coeruleus</td>
<td>Sedation  &lt;br&gt; Dry mouth  &lt;br&gt; Dizziness</td>
</tr>
<tr>
<td><strong>Benzodiazepines</strong></td>
<td>Enhances presynaptic and postsynaptic inhibition in the spinal cord through GABA pathways</td>
<td>Sedation  &lt;br&gt; Fatigue  &lt;br&gt; Habituation</td>
</tr>
<tr>
<td><strong>Dantrolene</strong></td>
<td>Inhibits release of calcium from muscle sarcoplasmic reticulum</td>
<td>Weakness  &lt;br&gt; Hepatotoxicity</td>
</tr>
<tr>
<td><strong>Clonidine</strong></td>
<td>Similar to tizanidine</td>
<td>Orthostatic hypotension</td>
</tr>
<tr>
<td><strong>Phenothiazines</strong></td>
<td>Reduces gamma motor excitability</td>
<td>Extrapyramidal side effects  &lt;br&gt; Sedation</td>
</tr>
</tbody>
</table>
Physical Therapy/Occupational Therapy

- Physical Treatments
  - ROM
  - Stretching
  - Serial casting
  - Dynamic splinting
  - Constraint induced therapy
- Therapeutic exercise
  - Strengthening
- Modalities
  - Electrical stimulation
  - Thermal modalities
- Combination
Chemodenervation – Botulinum toxin

- ...weakening and relaxation of muscle overactivity
- ...biomechanical change in the muscle’s function makes it amenable to stretching and lengthening
- ...weakening allows an opportunity to strengthening of antagonist muscles, and thereby it is possible to restore some of the balance between the two
Chemodenervation – Botulinum toxin

• ...improvements in tone 4 weeks after a single injection session of 500 U or 1000 U of abobotulinum toxin A

• ...these improvements were noted as early as week 1 and persisted for at least 12 weeks

• ...improvement in active range of motion in all movements assessed in the upper limb (elbow, wrist, or finger extension) in the abobotulinum toxin A 1000 U group, and a reduction of spasticity and spastic dystonia (Tardieu Scale).

• The results of this study might provide a rationale for the use of abobotulinum toxin A injected into co-contracting antagonists to improve active motion and not only to reduce resistance to passive movement.

Chemodenervation – Phenol

- Perineural injection of motor nerves using 3% to 6% phenol in aqueous solution
- LA effect followed by blockade 1 hour later
- Leaves the nerve with 25% less function than before
- Lasts for 4-6 months
- As an alternative to BOTOX, or surgery for focal problems
- Disadvantage
  - More time to perform
  - Can cause dysesthesia (if in proximity with sensory nerve fibres)
Surgery for Spasticity

1. Decrease Muscle Forces
2. Eliminate Muscle Forces
3. Redirect Muscle Forces
4. Mobilize Stiff Joints
5. Restore Balance to joints
6. Stabilize Joints

1. Restore Volitional Control to Muscles
2. Increase Muscle Force Generation
<table>
<thead>
<tr>
<th>Target Organ</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>Stereotactic Neurosurgery</td>
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<tr>
<td></td>
<td>Cerebellar stimulation</td>
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<tr>
<td>Spinal Cord</td>
<td>Posterior rhizotomy</td>
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<tr>
<td>Peripheral Nerve</td>
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<td>Joint</td>
<td>Fusion</td>
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<tr>
<td>Surgical Goals</td>
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<tr>
<td>1. Improved Function</td>
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<td>• Active function</td>
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<td>• Passive function</td>
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<td>2. Pain relief</td>
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<td>3. Decreased reliance on systemic medication</td>
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<td>4. Permanent solution rather than temporizing treatment</td>
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<tr>
<td>5. Improved Cosmesis</td>
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<td>6. Improved Hygiene</td>
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# Timing of Surgery

<table>
<thead>
<tr>
<th>Early Surgery</th>
<th>Later Surgery</th>
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<tbody>
<tr>
<td><strong>Advantages:</strong></td>
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<tr>
<td>• Supple joints</td>
<td>• Natural History of recovery more clearly known</td>
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<tr>
<td>• Shorter duration of disability</td>
<td>• Greater healing from initial injury</td>
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<tr>
<td><strong>Disadvantages:</strong></td>
<td><strong>Disadvantages:</strong></td>
</tr>
<tr>
<td>• Neurologic condition may still be dynamic and unpredictable</td>
<td>• Stiffer joints</td>
</tr>
<tr>
<td>• Medical morbidities and initial injury are relatively recent</td>
<td>• Longer disability</td>
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• **Neurectomy**
  
  • Partial sectioning of one or several motor branches of the nerves innervating the muscles to be targeted
  
  • Motor branches must be accessed where they are already clearly isolated from the nerve trunk or they must be dissected and identified as motor fascicles within the nerve trunk proximal to the formation of an identifiable branch

• No scientific data defining the extent of partial section (usually 75%)
• **Upper limb neurectomies**
  • 71 patients
  • Brachial plexus (3)
  • Musculocutaneous nerve (15)
  • Median/ulnar nerve (53)

• **Results**
  • Significant decrease in spasticity
  • Resting position, range of motion, active joint amplitude, and antagonist motor strength were improved
  • **Hand function**
    • 2/3 were operated for comfort and cosmetic gain
      • Significant improvement
    • 1/3 operated for functional improvement
      • 72.7% pressure paper function
      • 81.8% active hand opening

• **Pain**
  • Preop: 8.2, postop: 1.3
Musculocutaneous neurectomy

- 29 ptns / 30 neurectomies - 28/29 improved - No recurrence


- If no contracture


neurectomy of the motor branch of the ulnar nerve

- Intrinsic Spasticity

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Tendon Lengthenings

• Fractional lengthening

• Z-lengthenings
• Shoulder Fractional Lengthenings
  • 34 hemiparetic patients – all had lengthenings of pec major, lat dorsi and teres major, 4 also had long head of triceps fractional lengthening
  • ...significant improvement in AROM + pain


• Fractional lengthening of the brachialis tendon
  • + Z-lengthening of the biceps tendon + Proximal release of the BR


• Fractional lengthening of the finger flexors.
  • 27 patients/22 functional - 20/22 increased function - 2/22 decreased function – lost flexion

• Z-lengthening of the biceps tendon
  • + Fractional lengthening of the brachialis tendon + Proximal release of the BR,

• FCR, FCU: Z-lengthening
  • + FDS, FDP, FPL: fractional lengthening + PL: devided,

• ...FPL tendon lengthening
  • +/- IPJ fusion)

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</table>
• Proximal release of the BR,
  • Z-lengthening of the biceps tendon, Fractional lengthening of the brachialis tendon


• Flexor slide (elevation of all the forearm muscles from the bones and interosseous membrane)
  • Gives floppy hand rather than the fairly easily recognized deformity

• release of BR, Biceps, brachialis
• ...longitudinal incision on the lateral side of the elbow

• release of thenar muscles +/- 1st dorsal interosseous
  • (Proximal myotomy)
  • secondary to spasticity of Median and ulnar innervated thenar muscles

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Superficialis to profundus: STP

Braun

- distal section FDS
- proximal section FDP
- slide and terminal suture

→ limited active flexion

Optimal for non-functional hands

Courtesy to Mme Caroline Leclercq, Institut De La Main, Paris
Superficialis to profundus tendon transfer (STP)

......may be considered when the goal is to improve passive function only


(+ release of PL and lengthening of wrist flexors and FPL)


6 patients - Still fully passive motion - +/- FCR, FCU and FPL lengthening, CTD


31 patients - 34 hands - Motor branch of UN neurectomy in 25/34
Courtesy to Mme Caroline Leclercq, Institut De La Main, Paris
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</table>
Shoulder Tenotomies

pectoralis major, latissimus dorsi, teres major and subscapularis

• in nonfunctional extremity all four (pectoralis major, latissimus dorsi, teres major and subscapularis) should be released

• ...36 hemiplegic patients
• ....preop: pain, difficulty with dressing, skin care or hygiene
• ....postop: improved pain relief, passive ROM, hygiene, skin care and caregiver-assisted dressing.

• Division of brachialis
  • +/- lengthening of the biceps
• if spasticity + flexion contracture


• Division of Palmaris Longus
  • +FCR, FCU: Z-lengthening, FDS, FDP, FPL: fractional lengthening (Wrist and Finger Flexor Lengthening)

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</tbody>
</table>
Biceps Suspension Procedure

- pectoralis major tenotomy (if needed) – release of the insertion of lattisimus dorsi and teres major

- ...decrease in pain 11/11
- ...shoulder passive ROM was increased in all planes

<table>
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</table>
Wrist fusion

- The mean radiographic flexion deformity significantly improved from 67° pre-operatively to 4° of dorsal angulation post-operatively.

- +/- tenotomy of wrist flexors, +/- PRC

- Arthrodesis at neutral, or as close to neutral

- + superficialis-to-profundus transfer in non-functional hands with clenched fists


• Metacarpal head resection
  • fingers-in-palm deformity in longstanding neurological injury

• Not many spastic patients are candidates for surgery of their upper limb, because of the many other neurological problems frequently associated
• Stiffness

• CVA

• CVA to stiffness

• Treatment

• Take Home message
• 1,197 patients with acute stroke.

• The time course of functional recovery was strongly related to initial stroke severity.
  
  • Best ADL function
    
    • Mild Strokes - within 8.5 weeks (CI 8 to 9)
    • Moderate Strokes - within 13 weeks (CI 12 to 14)
    • Severe Strokes - within 17 weeks (CI 15 to 19)
    • Very severe Strokes - within 20 weeks (CI 16 to 24)

• After these time-points, no significant changes occurred.

• 1,197 patients with acute stroke.

• However, a **valid prognosis** of functional outcome can be made much earlier.
  
  • Best ADL function in 80% of the patients
    
    • mild strokes - within 3 weeks (CI 2.6 to 3.4)
    
    • Moderate Strokes - within 7 weeks (CI 6 to 8)
    
    • Severe and Very Severe Strokes - within 11.5 weeks (CI 10 to 13)

• A **reliable prognosis** can in all stroke patients be made within **12 weeks from stroke onset**. Even in patients with severe and very severe strokes, neurological and functional recovery should not be expected after the first 5 months

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any paresis in affected limb</td>
<td>0.001</td>
</tr>
<tr>
<td>MAS ≥2 in ≥1 joint within median 6 weeks poststroke</td>
<td>0.01</td>
</tr>
<tr>
<td>&gt;2 joints affected by increased muscle tone</td>
<td>0.002</td>
</tr>
<tr>
<td>Hemispasticity within median 6 weeks poststroke</td>
<td>0.01</td>
</tr>
<tr>
<td>Lower Barthel Index score at baseline</td>
<td>0.002</td>
</tr>
<tr>
<td>More severe paresis at median 16 weeks poststroke</td>
<td>0.02</td>
</tr>
</tbody>
</table>

• ...no benefits of additional physiotherapy using the current British approach for patients with initial severe arm impairment
• Uncontrolled spasticity can lead to permanent contracture in the muscles and soft tissues

• ...contracture can arise as a result of joint, muscle, or soft tissue limitations
prolonged immobilization of a joint, in a shortened position, results in contracture formation
58 y.o. , stroke
Severe spasticity

-pain
-difficulty in nursing

Courtesy to Mme Caroline Leclercq, Institut De La Main, Paris
• Is there a reason why we should wait for the contractures to develop?
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Thank you