



Pain in brachial plexus avulsion

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Pain in brachial plexus avulsion

- Brachial plexus Injury *Galen 1st aD*
- Birth-related brachial plexus palsy (obstetric brachial plexus paralysis) *Smillie 1764*
- Non-birth-related brachial plexus palsy *Flaubert 1827*
- Dorsal and ventral brachial plexus root avulsion *Adson 1922*
- Lumbosacral plexus avulsion *Nosik 1955*



Claudius Galenus 129-199



William Smillie 1697 -1763

524 ROBOTTI et al

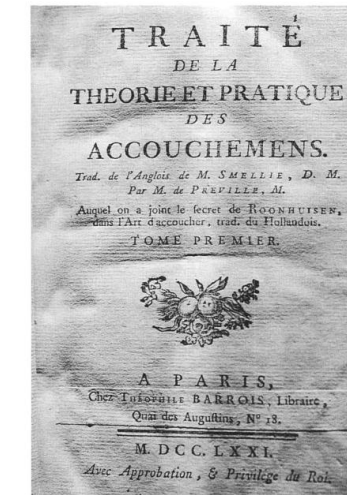
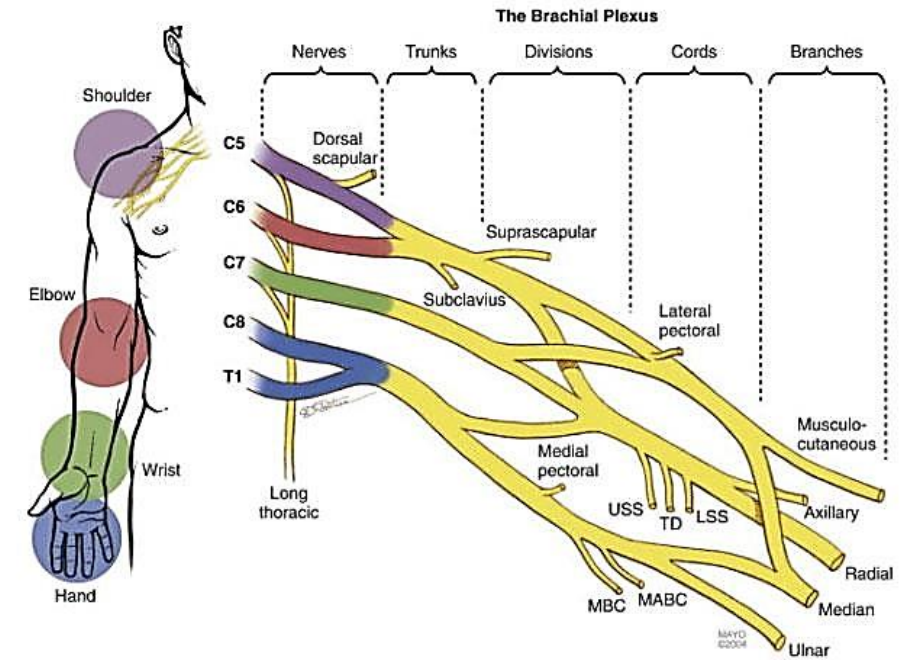
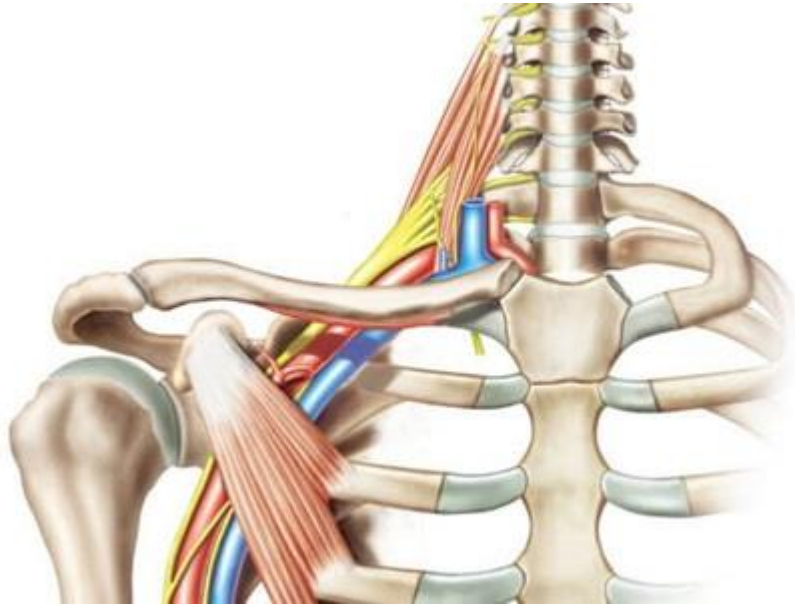


Figure 6. Frontispiece of Smellie's *Traité de la Théorie et Pratique des Accouchemens* (Treatise on the Theory and Practice of Delivery), French translation, Paris, Theophile Barrois, Libraire, 1771.

Pain in brachial plexus avulsion



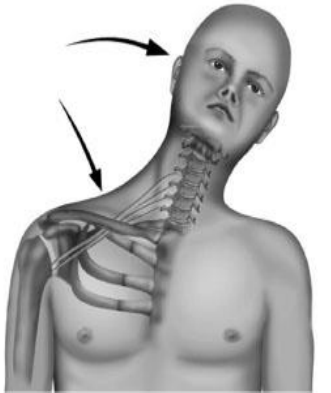
Vulnerability

- Dorsal root lacks epineurium and endoneurium
- Low complacence of cervical roots: shorter length and angulation predisposing to mechanical stretching
- Greatest structural fragility in the dorsal root entry region in the spinal cord [Benjamin 2005](#)

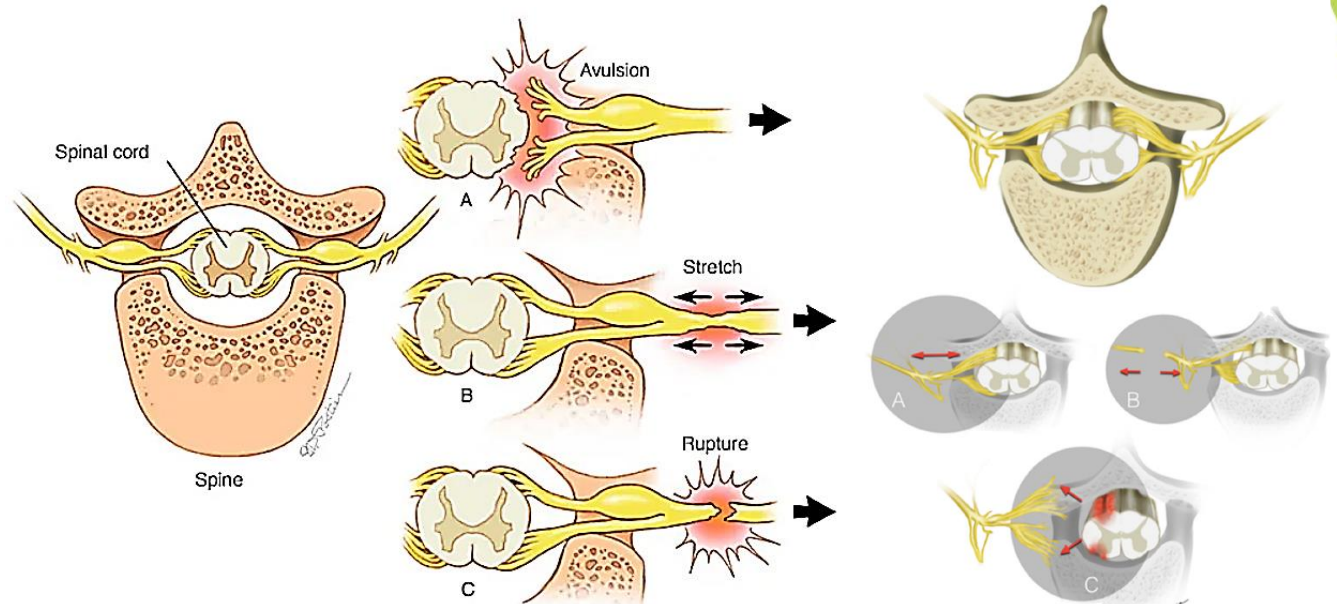
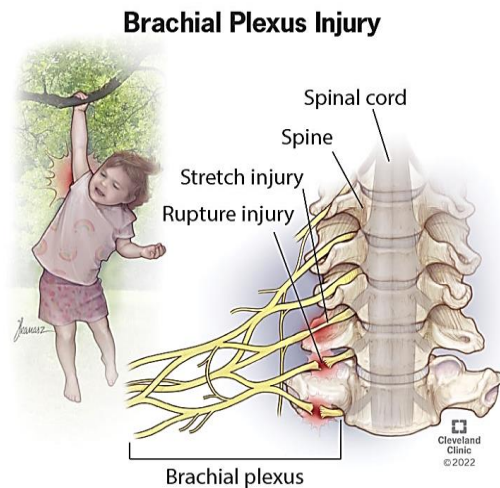
Pain in brachial plexus avulsion

Classification of Brachial Plexus Lesion

- Preganglionic lesions (root avulsion): discontinuation at their junction with the spinal cord
- Postganglionic lesions: rupture or discontinuity of nerve tissue distal to the dorsal root ganglion and or of brachial roots, plexular trunks, divisions or nerve branches entrapment by scar tissue
- Combination of lesions *Park et al. 2017*



Siqueira & Martins



Teixeira et al 2010

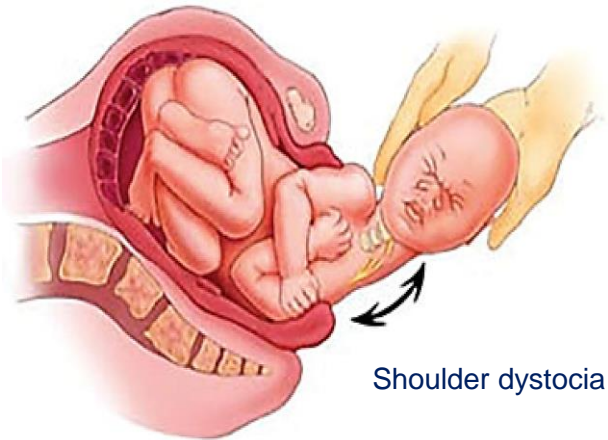
High-energy trauma to the upper extremity and or neck

Roots: Axonopraxia
Axonotmesis

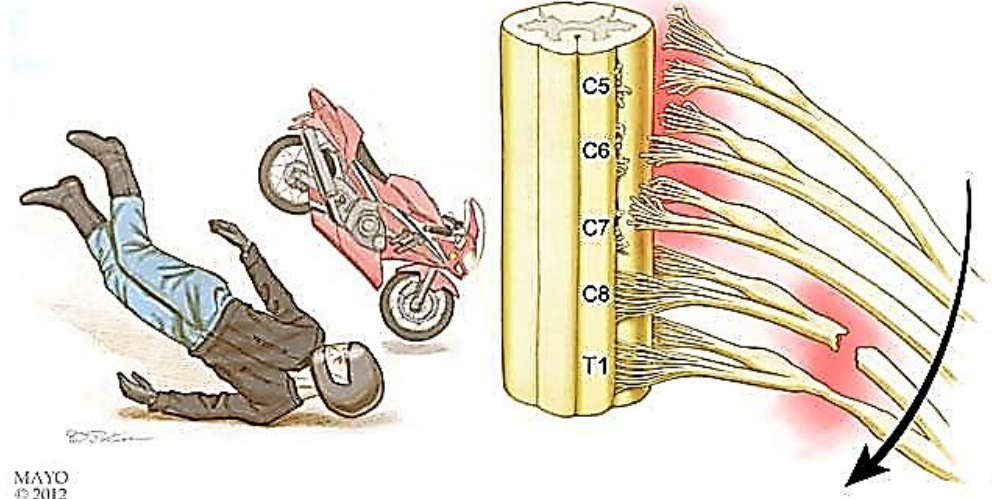
Brachial plexus: Neuropraxia
Axonotmesis
Neurotmesis

Pain in brachial plexus avulsion

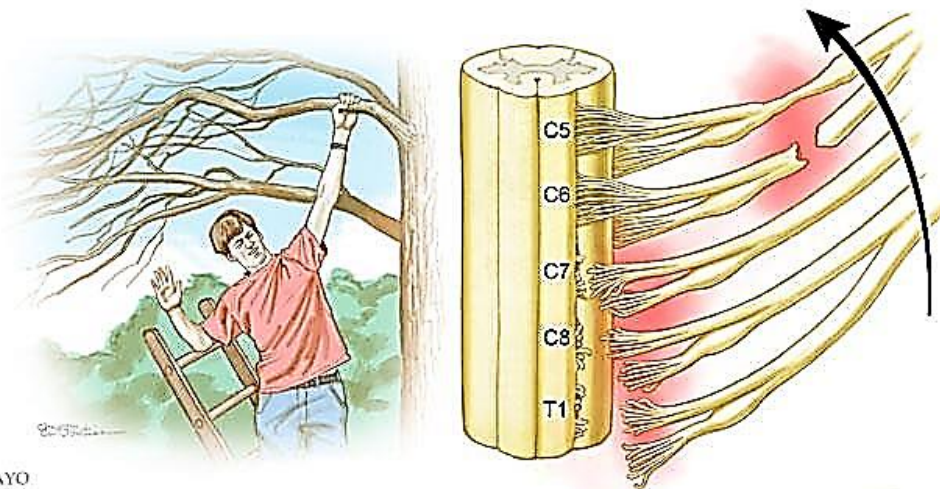
- Brachial plexus birth injury: 0.4–5.0/1,000 births *Lindqvist et al. 2012*
- Traumatic brachial plexus injuries: 1% of patients involved in major trauma *Midha 1997*
- Upward trend of occurrence *Dubuisson & Klin, 2002*



Galbiatti, Cardoso, Galbiatti 2020



Violent distraction of brachial plexus nerve structures



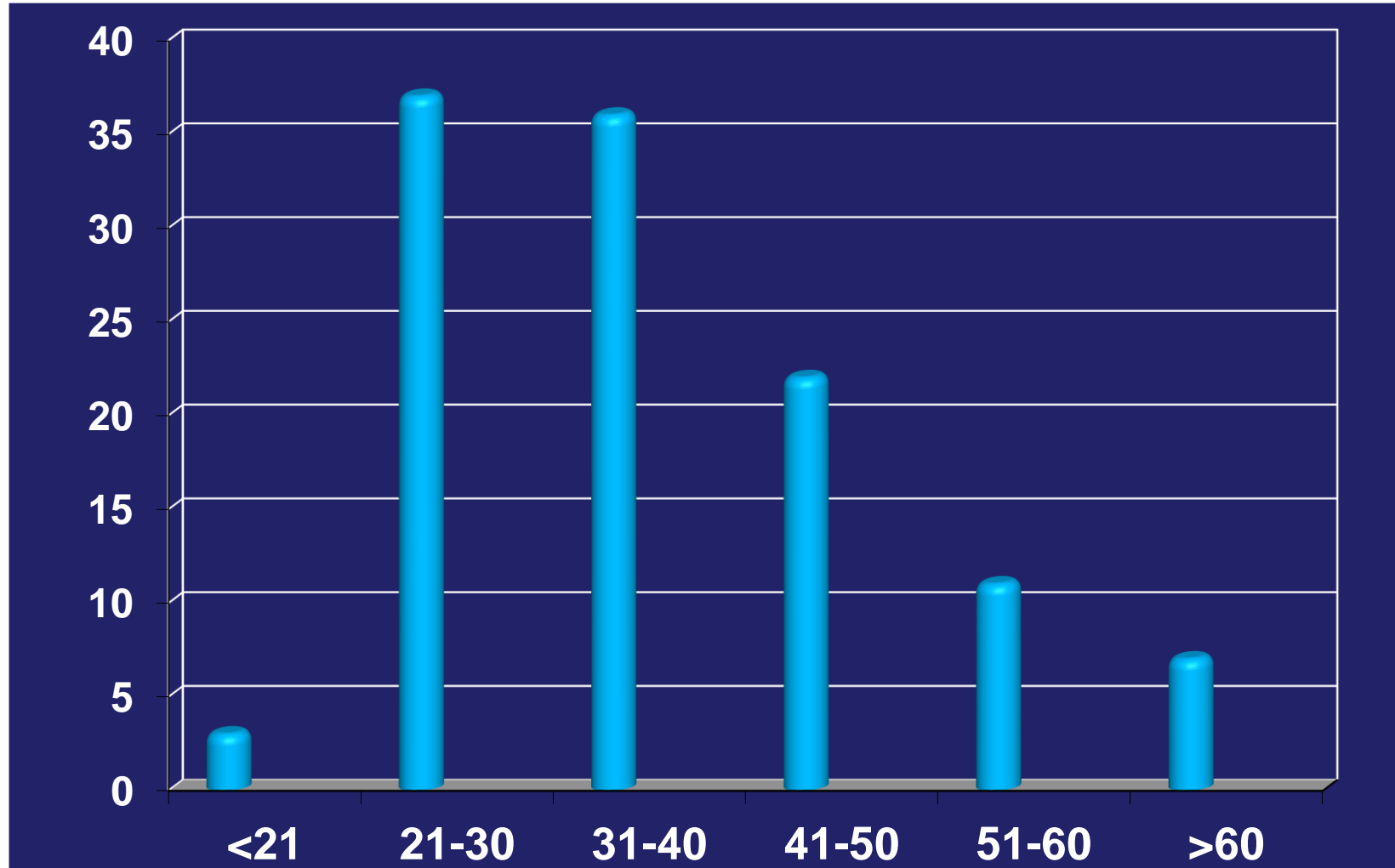
- 70% moto-vehicles accidents
- 70% motorcycles or bicycles *Narakas 1985*

| Trauma | % |
|------------------------------|------|
| • Motorcycle accident | 66.1 |
| • Car accident | 14.3 |
| • Trampling | 14.3 |
| • Industrial/sports/domestic | 5.0 |

Pain in brachial plexus avulsion

- Mean age of 26.4 yo
- Male 90.5%
- High social cost: man-hours of work lost by the patients and man-hours of caregivers work.
- Total indirect cost \$1,113,962 / patient over the postinjury lifetime [Hong et al. 2019](#)

Patients age range



N=116

24 – 79 yo (mean=40.3; sd=14.7)

Pain in brachial plexus avulsion

BPA in BPI patients

| Author(s) /year | Country/City | BPA in BPI series |
|----------------------|-------------------------|-------------------|
| Stevens 1934 | USA - Boston | 4 (3%) / 135 |
| Tracy e Brannon 1958 | USA -San Antonio | 9 (69%) / 13 |
| Davis 1947 | USA -Chicago | 2 (11%) /17 |
| Bonney 1959 | England - London | 13 (45%) / 29 |
| Taylor 1962 | USA - Los Angeles | 3 (50%) / 6 |
| Yeoman & Seddon 1963 | England - London | 86 (48%) /180 |
| Zorub 1974 | | 21 (30%) /70 |
| Ishijima 1988 | Japan | 19 (54%) / 35 |
| Thomas & Sheehy 1988 | England - London | 19 (100%) |
| Birch 1996 | England - London | 148 (12%) / 1162 |
| Htut 2006 | England – London | 76 (100%) |
| Flores 2006 | Brazil - Brasilia | 16 (76%) / 20 |
| Ciaramitaro 2010 | Brazil - Sao Paulo | 2 (10%) / 7 |
| Bertelli 2011 | Brazil – Florianopolis | 64 (42%) / 150 |
| Jain 2012 | Índia – Tamil Nad | 70 (23%) / 304 |
| De Moraes 2015 | Brazil - Goiania | 10 (21%) of 48 |
| Zhou 2016 | China - Shanghai | 30 (100%) |
| Bertelli 2017 | Brazil - Florianopolis | 257 (45%) / 512 |
| Patroclo 2018 | Brazil - Rio de Janeiro | 50 (44%) / 114 |
| Clifton 2018 | USA – Mayo Clinic | 74 (16%) / 454 |

•Upper limb amputation: 50–85%

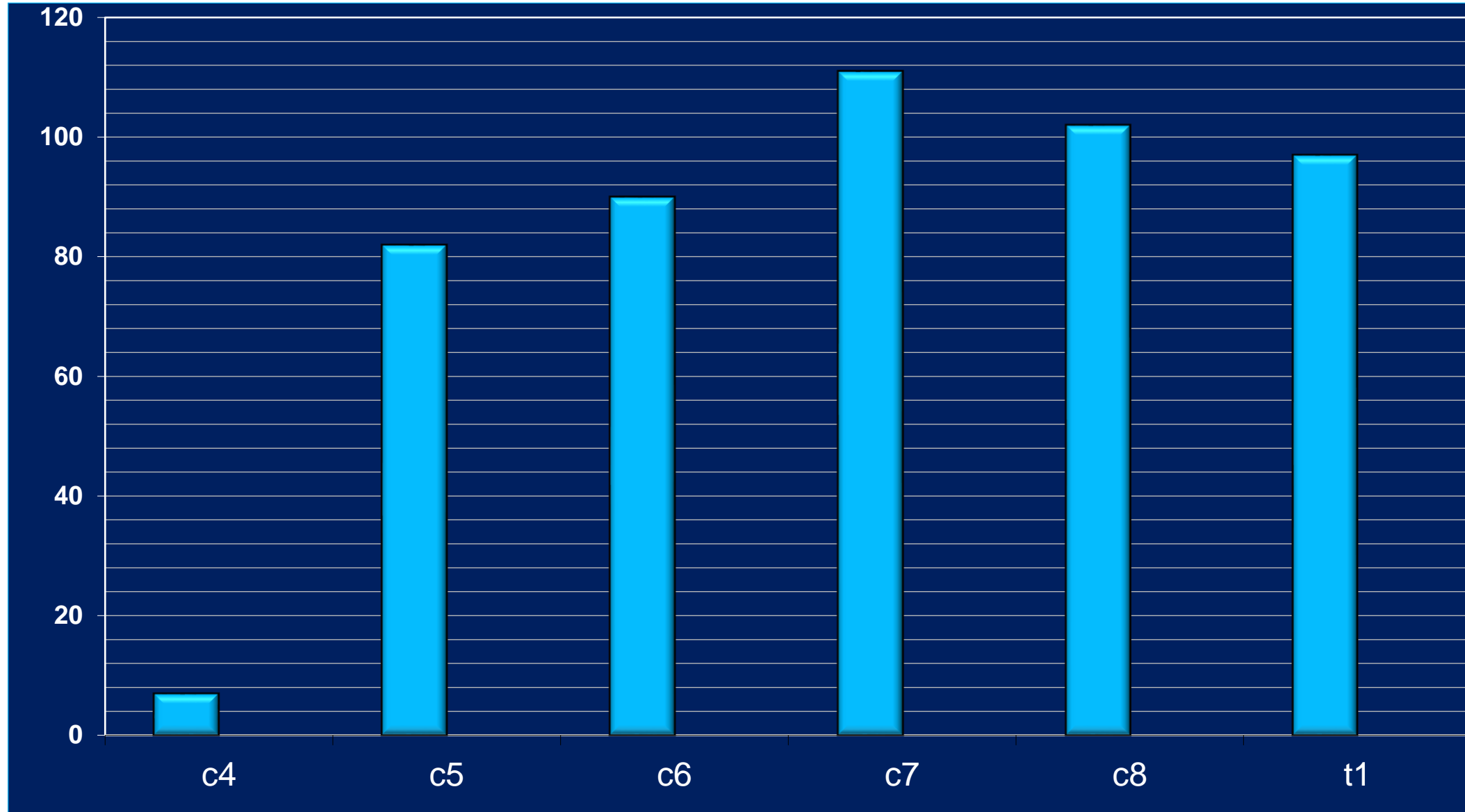
► chronic pain: 54–87%

► phantom limb pain

•CRPS: 21%

Pain in brachial plexus avulsion

Cervical roots avulsed



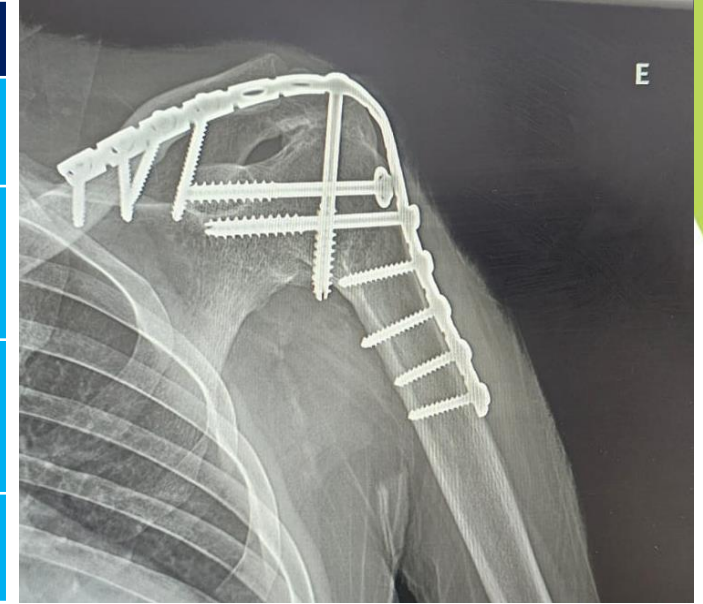
N=116

≥3 roots

Pain in brachial plexus avulsion

Other traumatic lesions

| Associated injuries | N | (%) |
|-----------------------------|----|--------|
| Bone fractures | 67 | (57.8) |
| Impairment of consciousness | 61 | (52.6) |
| Vascular lesions | 5 | (4.3) |
| Visceral lesions | 6 | (5.2) |



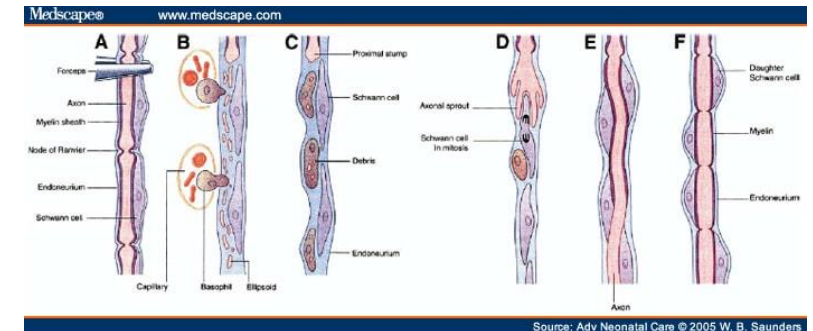
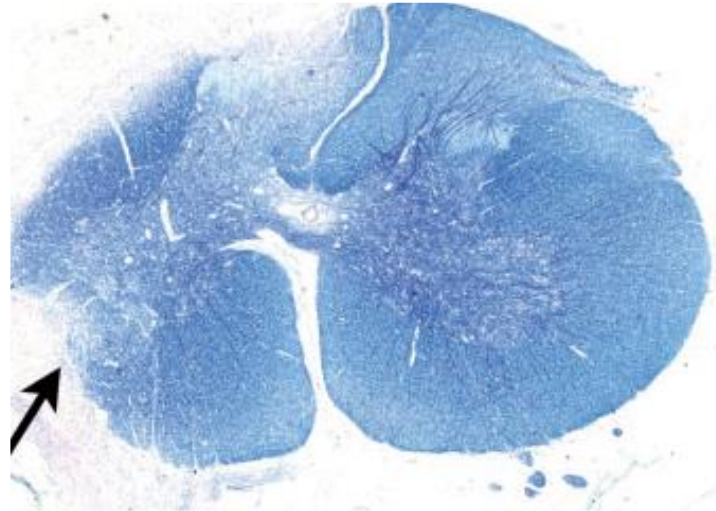
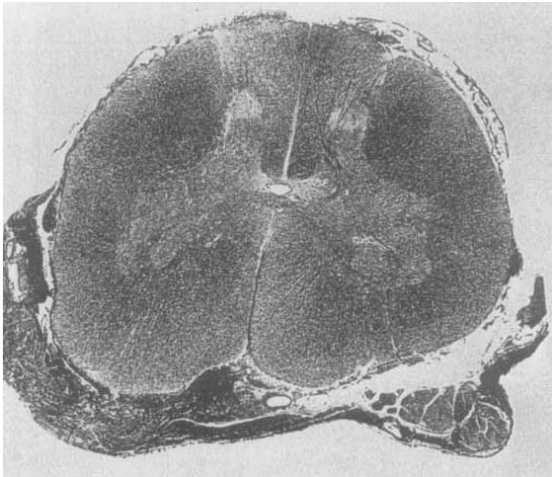
N=116

| Associated orthopedic lesions | N | % |
|---------------------------------|----|---------|
| Hand | 4 | (3,4) |
| Forearm or upper arm | 26 | (22,0) |
| Lower limb | 19 | (16,4) |
| Shoulder or shoulder girdle | 1 | (0,9) |
| Pelvis | 4 | (3,4) |
| Ribs | 6 | (5,2) |
| Jaw | 4 | (3,4) |
| Vertebrae | 4 | (3,4) |
| Traumatic lower limb amputation | 2 | (1,7) |
| Total | 70 | (100,0) |

| Surgery just after admission to the ER 49% | N | % |
|---|----|----------|
| Thoracic and/or abdominal | 6 | (5,2) |
| Neurosurgery | 7 | (6,0) |
| Orthopedic | 29 | (25,0) |
| Vascular | 5 | (4,3) |
| Total | 47 | (100,00) |

Pain in brachial plexus avulsion

- Motor, sensory, and sympathetic disturbances upper limb, shoulder, and or diaphragm motor deficits, areflexia...: 100%
- Autonomic disturbances: Claude Bernard-Horner's (64.0%)*, temperature, upper limb vascular perfusion.....
- Sensory negative symptoms and or signs: nociceptive, tactile and or thermal anaesthesia or hypoesthesia
- Positive sensory symptoms and or signs: neuropathic, nociceptive, nociplastic and mixed pains, hyperalgesia & allodynia, Tinel-Hoffman's sign over the cervical or proximal upper limb (74.6%)*
- Dystrophic sequelae: skin, subcutaneous tissue, musculoskeletal structures and vessels *Simon et al. 2015*



Central neuropathic pain: lesion of Lissauer's tract and laminae I and II of the DH *Sindou, 1974; Guenot et al. 2003*

Pain in brachial plexus avulsion

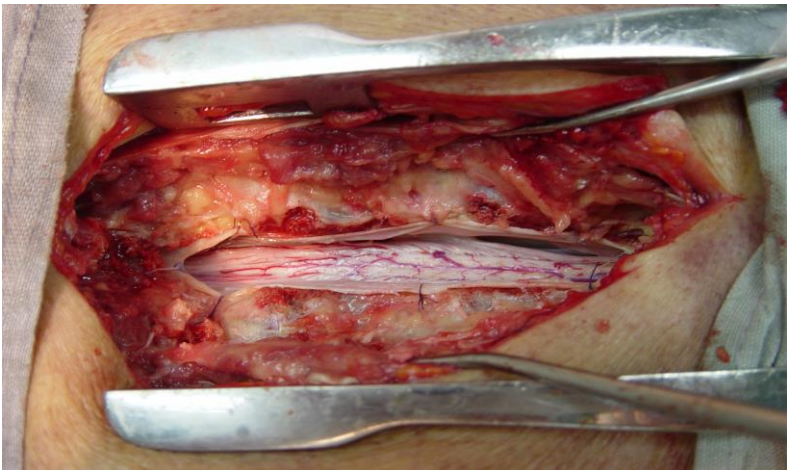
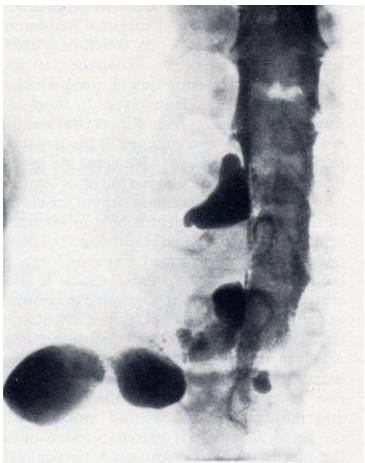
- Dysfunctions deficits. and disabilities
- Impairment of self steen
- Sensorial, motor, autonomic deficits and physical and psychological sequelae + mixed pains

- Use of slings 58.9%
- Scoliosis 80.4%

| QoL impairment | % |
|-------------------------|------|
| •Pain | 64.3 |
| •Motor deficit | 14.3 |
| •Pain and motor deficit | 8,9 |
| •Other | 8,9 |



Siqueira & Martins



Pain in brachial plexus avulsion

Grade of upper limb functionality

| DASH | Right upper limb | Left upper limb |
|---------|------------------|-----------------|
| Minimum | 84.1 | 18.3 |
| Maximum | 1.6 | 76.6 |
| Mean | 43.0 | 47.3 |
| SD | 26.8 | 29.1 |

N=116

Pain in brachial plexus avulsion

- Prevalence: 70% of the patients *Bonnard & Barakas 1985, Brussels 1988, Zhou et al. 2016*
- Severe 10%-25% of the patients
- The most important complaint: 10%-90% of the patients *Zorub et al. 1974*
- Higher occurrence: number of (superior avulsed) roots, older patients *Htut 2006,*
- Less common in C8-T1 avulsion *Bertelli et al. 2011*
- Predisposing factors: alcohol abuse, smoking, psychiatric co-morbidities, marital status *Saiz-Sapena et al.*
- Time life occurrence and intensity: spontaneous progressive improvement ► 30% 3 years later
- Temporal presentation: acute / chronicle
- Quality of neuropathic pains
 - Constant: tingling, burning, crushing, tearing, throbbing, pulling...
 - Paroxysmal: shooting, electric shocks/ seconds - minutes *Naraka 1979, Teixeira et al. 1999*

Pain in brachial plexus avulsion

Pain aetiologies & mechanisms

Aetiology of pain

- Neuropathic *Simon et al. 2015*
 - Peripheral nervous system: brachial plexus trauma *Davis et al. 1947*
 - Central nervous system: root avulsion *Teixeira 2005*
- Non-neuropathic pains
 - Musculoskeletal: osteoarticular, myofascial
 - Other organs
 - Unrelated
 - Psychogenic"/nociplastic



Mixed pains



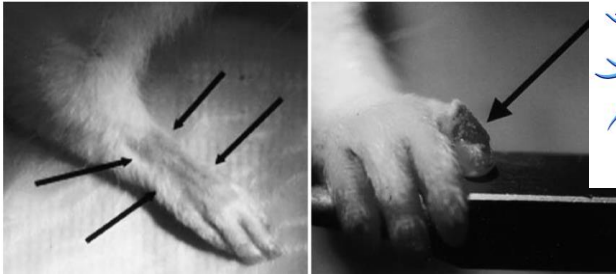
- Neuropathic pain: 67%
- Non-neuropathic pain: 33% *Ciaramitaro et al. 2010*

Severe dysfunctions and disabilities and impairment of social integrity

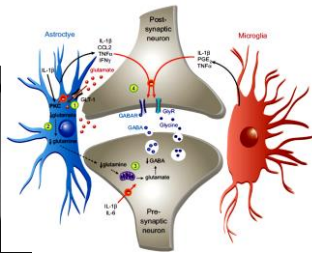
Pain in brachial plexus avulsion

- Neuropathic pain (NeP): “pain arising as a direct consequence of a lesion, or disease affecting the somatosensory system” *Treede et al., 2008*
- Avulsion ► central neuropathic pain: lesion between the root entry point into the spinal cord to 2 mm deep into the DH (laminae I - II) *Teixeira, 2015, Mohanty et al. 2016, Sindou 1974, Guenot et al. 2003*
- Traumatic plexopathy ► peripheral neuropathic pain: post-ganglionic ectopic potentials, ephaptic currents, sympathetic abnormalities
- Desinhibition of nociceptive DH neurons *Naraka 1979, Parry 1980, Nashold 1988, Teixeira et al. 1999*
- Sprouting of intact fibers
- Glia activation: release of chemokines and pro-inflammatory cytokines ► pain signaling (CGRP, SP, glutamate) *Paszczuk et al. 2011, Zhong 2021*
- Microglia ► proinflammatory cytokines: maladaptive neuroplasticity BDNF activity *Huang et al. 2021*
- Sensitisation and neuroplasticity of supraspinal neurons

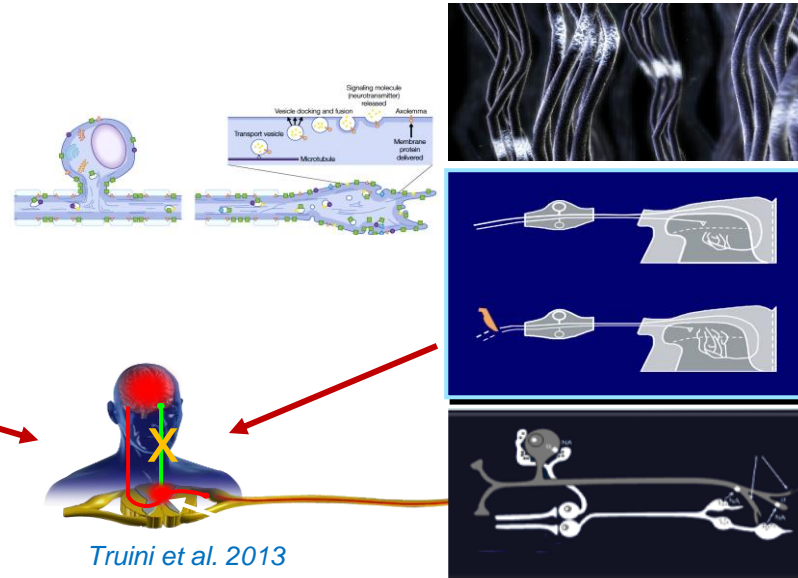
Avulsion: central neuropathic pain



Guenot et al. 2002



Traumatic plexopathy: peripheral neuropathic pain



Truini et al. 2013

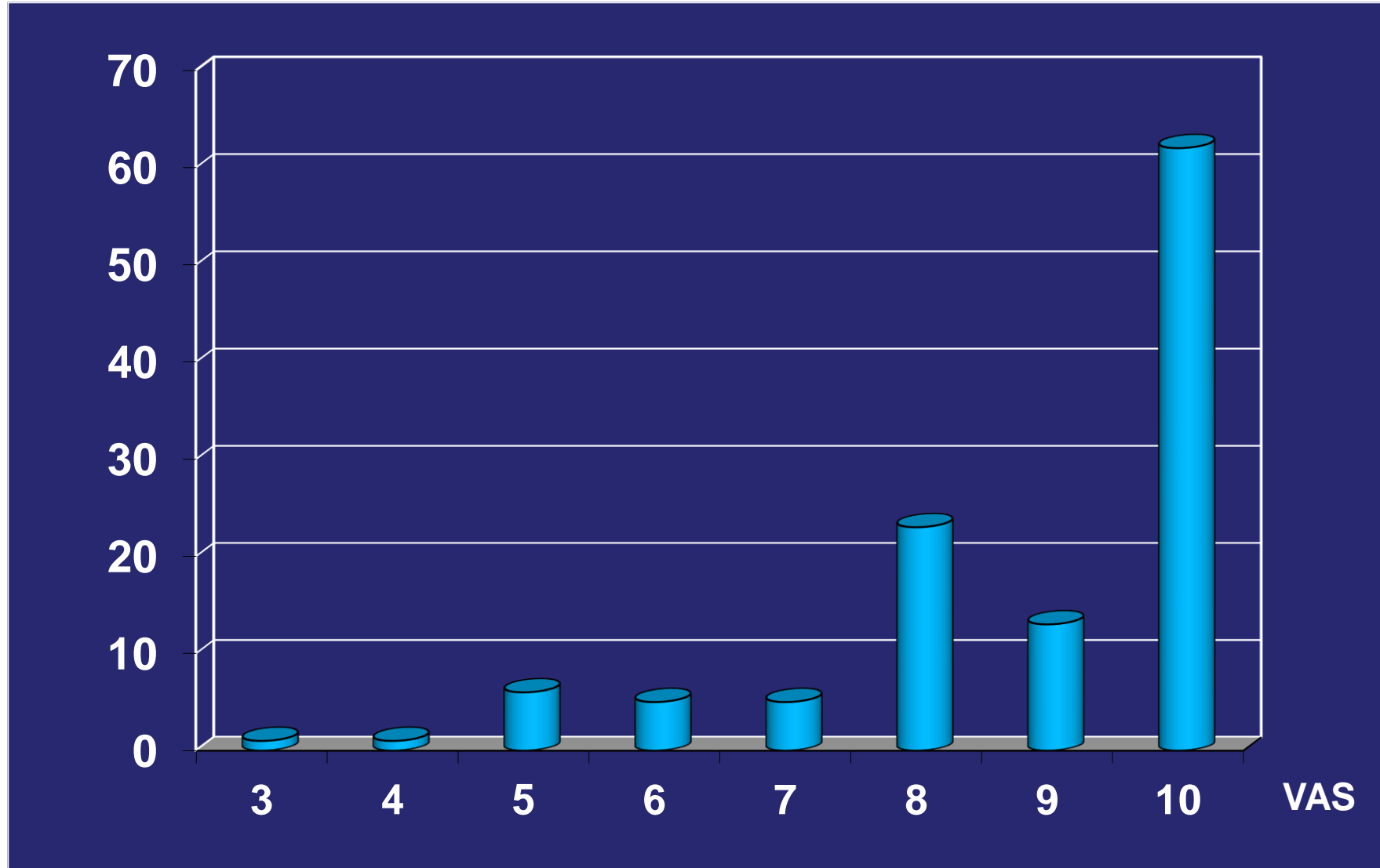
Non neuropathic nociceptive pain



Neuropathic pain

Pain in brachial plexus avulsion

VAS Pain scores



N=116

Hand (92%)

Forehand (90%)

Arm (40%)

Shoulder (6%)

Cervical region VAS=96

Scapular region VAS=90

MPS:

Trapezius

Escalenes

Sternocleidomastoid

Body axis muscles

Pain in brachial plexus avulsion

Predominant location of pain

The most frequent localizations of neuropathic pain: hand, wrist, forearm, and elbow *Bonney 1959*

| Location of pain | Left | | Right | | Total | |
|-------------------------------------|------|--------|-------|--------|-------|---------|
| | N | (%) | N | (%) | N | (%) |
| Hand, forearm | 18 | (15.5) | 34 | (29.3) | 52 | (44.8) |
| Hand, forearm, arm | 22 | (19.0) | 16 | (13.8) | 38 | (32.8) |
| Hand | 1 | (0.9) | 7 | (6.0) | 8 | (6.9) |
| Hand, forearm, arm, cervical | 2 | (1.7) | 1 | (0.9) | 3 | (2.6) |
| Hand, forearm, arm, shoulder | 1 | (0.9) | 1 | (0.9) | 2 | (1.7) |
| Hand, forearm, arm, shoulder, chest | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Hand, forearm, upper arm, chest | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Hand, forearm, shoulder | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Shoulder, arm | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Shoulder, arm, forearm, hand | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Shoulder, hand, forearm | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Arm, hand | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Arm | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Forearm, arm, hand, cervical | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Forearm, arm | 1 | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Foot | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Foot, knee | - | (0.0) | 1 | (0.9) | 1 | (0.9) |
| Foot, leg | 1 | (0.9) | - | (0.0) | 1 | (0.9) |
| Total | 50 | (43.1) | 66 | (56.9) | 116 | (100.0) |

N=116

(%)
Neuropathic pains: 44,1
Mixed pains: 55,8
 Neck 28.6
 Dorsal region 19.6
 Whole Back 14.3
 Low back 12.5
 Pectoral region 8.9
 Head 7.1

Pain in brachial plexus avulsion

Phantom sensations

- Static 83.3%
- Dynamic 81,0%
- Perception of movement during sleep 54,8%.
- Phantom limb touching ipsilateral hemiface 75.0%
- Dysmorphometry 16.3%
 - Limb shortening 16.1%
 - Limb stretchig 37.5%

| Phantom limb pain and sensation aspects, n (%) | MP | NP | No Pain | p* |
|---|-----------------|-----------------|----------------|---------|
| Phantom limb pain after injury, yes | 19 (100) | 16 (100) | 7 (100) | 0.123** |
| Interval between the appearance of phantom limb pain and the injury | | | | |
| first week | 3 (15.8) | 7 (43.7) | 0 (0.0) | 0.048** |
| firsts 6 months | 3 (15.8) | 4 (25.0) | 5 (71.4) | |
| more then 6 months | 13 (68.4) | 5 (31.3) | 2 (28.6) | |
| Still has phantom limb pain | | | | |
| No | 3 (15.8) | 5 (31.3) | 1 (14.3) | 0.475** |
| Yes | 16 (84.2) | 11 (68.7) | 6 (85.7) | |
| Phantom limb pain frequency | | | | |
| Sometimes a year | 2 (10.5) | 0 (0.0) | 3 (42.8) | 0.130** |
| Sometimes a week | 6 (31.6) | 5 (31.3) | 2 (28.6) | |
| Daily | 8 (42.1) | 6 (37.6) | 1 (14.3) | |
| Not applicable | 3 (15.8) | 5 (31.3) | 1 (14.3) | |
| Phantom limb thermal sensation (burning / freezing) | | | | |
| No | 12 (63.2) | 13 (81.2) | 6 (85.7) | 0.352** |
| Yes | 7 (36.8) | 3 (18.8) | 1 (14.3) | |
| phantom limb non-thermal sensation (itch, shock, heavy) | | | | |
| No | 13 (68.4) | 14 (87.5) | 5 (71.4) | 0.397** |
| Yes | 6 (31.7) | 2 (12.5) | 2 (28.6) | |
| phantom limb movement sensation | | | | |
| No | 7 (36.8) | 9 (56.3) | 3 (15.8) | 0.512** |
| Yes | 12 (63.2) | 7 (43.7) | 4 (17.4) | |
| Phantom limb no-movement sensation (position, shape, something that touches) | | | | |
| No | 8 (42.1) | 8 (50.0) | 5 (71.4) | 0.415** |
| Yes | 11 (57.9) | 8 (50.0) | 2 (28.6) | |
| Dynamic phantom limb sensation (opens and closes the hand, rotates, or rocks the limb) | | | | |
| No | 7 (36.8) | 9 (56.3) | 3 (42.9) | 0.512** |
| Yes | 12 (63.2) | 7 (43.7) | 4 (57.1) | |
| Static phantom limb sensation (member stretched or flexed) | | | | |
| No | 10 (52.6) | 11 (68.7) | 6 (85.7) | 0.264** |
| Yes | 9 (47.3) | 5 (31.3) | 1 (14.3) | |
| The phantom limb sensation moves involuntarily | | | | |
| No | 6 (31.6) | 7 (43.7) | 3 (42.9) | 0.731** |
| Yes | 13 (68.4) | 9 (56.3) | 4 (57.1) | |
| Phantom limb sensation interference in habitual tasks | | | | |
| Moderate / very much | 2 (10.6) | 1 (6.2) | 0 (0.0) | 0.753** |
| Little / nothing | 13 (68.4) | 10 (62.5) | 6 (85.7) | |
| Not applicable/ without answer | 4 (21.0) | 5 (6.3) | 1 (14.3) | |
| Total | 19 (100) | 16 (100) | 7 (100) | |

*χ² test

** Yates correction

Pain in brachial plexus avulsion

Progression, rytmy, lokalizacja, i charakter bólu

| Parameter | Feature | N | (%) |
|--------------|-------------------------|-----|---------|
| Followup | Stable | 100 | (86,2) |
| | Progressive | 13 | (11,2) |
| | Regressive | 2 | (1,7) |
| | Floating | 1 | (0,9) |
| | TOTAL | 116 | (100,0) |
| Rytmy | Morning | 2 | (1,7) |
| | Night | 13 | (11,2) |
| | Daytime | 99 | (85,4) |
| | Morning and night | 2 | (1,7) |
| | TOTAL | 116 | (100,0) |
| Localization | Deep | 108 | (93,1) |
| | Superficial | 4 | (3,4) |
| | Superficial and deep | 4 | (3,4) |
| | TOTAL | 116 | (100,0) |
| Character | Constant | 83 | (71,6) |
| | Paroxysmal | 4 | (3,5) |
| | Paroxysmal and constant | 29 | (25,0) |
| | TOTAL | 116 | (100,0) |

Pain in brachial plexus avulsion

MPQ pain descriptors

Mean global score = 11.7 (>evaluative)

| Sensitive | N | Affective | N | Evaluative | N | Miscelanea | N |
|-----------|----|-------------|----|-------------|----|------------|----|
| Burning | 80 | Sickening | 19 | Intense | 57 | Cool | 14 |
| Flashing | 58 | Tiring | 18 | Unbearable | 27 | Tight | 12 |
| Tingling | 34 | Blinding | 16 | Troublesome | 12 | Drawing | 8 |
| Throbbing | 31 | Frightful | 16 | Miserable | 6 | Torturing | 7 |
| Jumping | 29 | Exhausting | 8 | Annoying | 6 | Cold | 6 |
| Pricking | 28 | Fearful | 8 | | | Numb | 5 |
| Tugging | 20 | Grueling | 8 | | | Spreading | 5 |
| Heavy | 17 | Suffocating | 7 | | | | |
| Pressing | 14 | Vicious | 7 | | | | |
| Aching | 12 | Terrifying | 5 | | | | |
| Pinching | 12 | Punishing | 4 | | | | |
| Smarting | 10 | Wretched | 4 | | | | |
| Crushing | 9 | Punshing | 4 | | | | |

N=116

Phantom Limb Pain 23 (18.8%) 40%

Active 14 (60.9%)

Static 5 (21.7%)

Sporadic 4 (17.4%)

Dominant 14 (60.9%)

Non-dominant 9 (39.1%)

Pain in brachial plexus avulsion

Number of NPSI descriptors higher in mixed pain / neuropathic pain patients

| Roots avulsion diagnoses, n (%) | | | | 0.695 |
|---------------------------------|-----------------|-----------------|-----------------|-------|
| 1 or 2 roots | 8 (36.3) | 9 (41) | 5 (22.7) | |
| 3 roots | 2 (18.2) | 5 (45.4) | 4 (36.4) | |
| 4 or 5 roots | 9 (39.2) | 10 (43.4) | 4 (17.4) | |
| Total | 19 (100) | 24 (100) | 13 (100) | |

Table 3S. Distribution of pain according to injury characteristics among patients with BPA

| Variable | Pain | | No Pain | | Total | | p* |
|---------------------------------------|------|------|---------|------|-------|-----|----------|
| | n | % | n | % | n | % | |
| Lesion cause | | | | | | | |
| Motocycle accident | 28 | 75,7 | 9 | 24,3 | 37 | 100 | 0,952** |
| Others | 15 | 78,9 | 4 | 21,1 | 19 | 100 | |
| Main cause of annoyance | | | | | | | |
| Pain with or without lack of movement | 40 | 97,6 | 1 | 2,4 | 41 | 100 | <0,001** |
| Others | 3 | 20 | 12 | 80 | 15 | 100 | |
| Total | 43 | 76,8 | 13 | 23,2 | 56 | 100 | |

| NPSI - Descriptives | NP | MP | No Pain | p | M x NP p** | M x NoP p** | NP x NoP p** |
|-------------------------------|-------------|-------------|-------------|---------|---------------|----------------|-----------------|
| Burning | 4,89 ± 3,68 | 6,92 ± 2,86 | 0,46 ± 1,20 | < 0.001 | 0.616 | < 0.001 | 0.002 |
| Squeezing | 3,79 ± 3,91 | 5,33 ± 3,87 | 0,00 ± 0,00 | < 0.001 | 0.424 | < 0.001 | 0.003 |
| Pressure | 3,63 ± 3,89 | 4,88 ± 3,62 | 0,15 ± 0,55 | < 0.001 | 0.472 | < 0.001 | 0.017 |
| Electric Shocks | 4,84 ± 4,13 | 5,50 ± 3,01 | 0,61 ± 2,22 | < 0.001 | 0.940 | < 0.001 | 0.009 |
| Stabbing | 3,79 ± 4,24 | 4,50 ± 3,67 | 0,00 ± 0,00 | 0.001 | 0.780 | < 0.001 | 0.013 |
| Provoked by brushing | 1,68 ± 3,06 | 4,42 ± 4,06 | 0,15 ± 0,55 | 0.001 | 0.059 | 0.003 | 0.216 |
| Provoked by pressure | 1,74 ± 3,30 | 5,17 ± 3,64 | 0,15 ± 0,55 | < 0.001 | 0.008 | < 0.001 | 0.322 |
| Provoked by contact with cold | 2,68 ± 4,03 | 5,38 ± 3,74 | 0,00 ± 0,00 | < 0.001 | 0.094 | < 0.001 | 0.042 |
| Pins and needles | 3,21 ± 4,17 | 4,58 ± 4,03 | 0,61 ± 2,22 | 0.012 | 0.556 | 0.007 | 0.099 |
| Tingling | 5,21 ± 4,24 | 4,75 ± 3,85 | 1,46 ± 3,23 | 0.025 | 0.785 | 0.042 | 0.036 |

Pain in brachial plexus avulsion

BPI, DN4, and NPSI scores higher in mixed pain patients

| Characterization of pain syndromes in patients with brachial plexus avulsion, n (%) | NP 19 (33.9) | MP 24 (42.9) | No Pain 13 (23.2) | <i>p</i> * | MP x NP <i>p</i> ** | MP x NoP <i>p</i> ** | NP x NoP <i>p</i> ** |
|---|--------------------|--------------------|--------------------|-------------------|---------------------------|----------------------------|----------------------------|
| <i>BPI pain VAS (0–100)</i> | 69.8 ± 28.9 | 72.6 ± 23.7 | 0.92 ± 2.78 | <0.001 | 0.928 | < 0.001 | < 0.001 |
| <i>BPI pain intensity (0–10)</i> | 6.21 ± 1.75 | 6.46 ± 1.47 | 0.53 ± 1.45 | <0.001 | 0.942 | < 0.001 | < 0.001 |
| <i>BPI pain interference (0–10)</i> | 5.09 ± 2.80 | 6.75 ± 2.42 | 1.19 ± 3.02 | <0.001 | 0.174 | < 0.001 | < 0.001 |
| <i>DN4 score (0–10)</i> | 5.74 ± 1.69 | 7.21 ± 1.25 | 3.15 ± 1.77 | <0.001 | 0.008 | < 0.001 | 0.002 |
| <i>No-neuropathic pain, DN4 < 4, n (%)</i> | 2 (11.8) | 0 (0) | 9 (69.2) | | | | |
| <i>Neuropathic pain, DN4 > 4, n (%)</i> | 17 (88.2) | 24 (100) | 4 (30.8) | | | | |
| Quality of neuropathic pain (NPSI) | | | | | | | |
| <i>Continuous ongoing superficial pain (burning), Intensity (0–10)</i> | 4.89 ± 3.68 | 6.92 ± 2.86 | 0.46 ± 1.20 | <0.001 | 0.161 | < 0.001 | 0.002 |
| <i>Continuous ongoing deep pain (pressure/squeezing), Intensity (0–10)</i> | 3.71 ± 3.46 | 5.10 ± 3.32 | 0.07 ± 0.27 | <0.001 | 0.340 | < 0.001 | < 0.001 |
| <i>Evoked pain (allodynia to brush, cold and pressure), Intensity (0–10)</i> | 4.32 ± 3.71 | 5.00 ± 2.53 | 0.30 ± 1.11 | <0.001 | 0.742 | < 0.001 | 0.003 |
| <i>Paroxysmal pain (electric shocks/stabbing), Intensity (0–10)</i> | 2.04 ± 2.47 | 4.99 ± 3.05 | 0.10 ± 0.37 | <0.001 | 0.007 | < 0.001 | 0.009 |
| <i>Paraesthesia/Dysaesthesia (tingling, pins and needles), Intensity (0–10)</i> | 4.21 ± 3.08 | 4.67 ± 2.85 | 1.04 ± 1.83 | 0.002 | 0.986 | 0.002 | 0.008 |
| <i>NPSI- total score (0–100)</i> | 3.55 ± 2.02 | 5.14 ± 2.04 | 0.36 ± 0.54 | <0.001 | 0.036 | < 0.001 | < 0.001 |
| <i>Brief-MPQ, Sensory (0–8)</i> | 0.71 ± 0.25 | 0.81 ± 0.18 | 0.14 ± 0.25 | <0.001 | 0.414 | < 0.001 | < 0.001 |
| <i>Affective (0–5)</i> | 0.76 ± 0.29 | 0.73 ± 0.30 | 0.06 ± 0.15 | <0.001 | 0.918 | < 0.001 | < 0.001 |
| <i>Evaluative (0–2)</i> | 0.86 ± 0.23 | 0.79 ± 0.25 | 0.19 ± 0.33 | <0.001 | 0.629 | < 0.001 | < 0.001 |
| <i>Total score (0–15)</i> | 11.40 ± 3.20 | 12.00 ± 2.68 | 1.77 ± 3.00 | <0.001 | 0.926 | < 0.001 | < 0.001 |
| BPI - functional Interference | NP | MP | No Pain | <i>p</i>* | MP x NP <i>p</i>** | MP x NoP <i>p</i>** | NP x NoP <i>p</i>** |
| General activity | 5.00 ± 3.20 | 7.50 ± 2.41 | 0.73 ± 2.41 | < 0.001 | 0.032 | < 0.001 | 0.005 |
| Mood | 5.63 ± 3.32 | 6.08 ± 3.40 | 0.45 ± 1.51 | < 0.001 | 0.908 | < 0.001 | < 0.001 |
| walking ability | 4.42 ± 3.78 | 6.46 ± 3.45 | 1.18 ± 3.06 | 0.002 | 0.180 | 0.004 | 0.044 |
| Normal work | 6.11 ± 4.57 | 7.96 ± 3.21 | 0.73 ± 2.41 | < 0.001 | 0.452 | < 0.001 | 0.005 |
| Relation with other people | 4.16 ± 3.95 | 5.92 ± 3.57 | 1.36 ± 3.04 | 0.005 | 0.272 | 0.004 | 0.131 |
| Sleep | 5.79 ± 3.99 | 7.92 ± 2.65 | 0.00 ± 0.00 | < 0.001 | 0.167 | < 0.001 | < 0.001 |
| Enjoyment of life | 4.53 ± 3.56 | 5.46 ± 3.81 | 1.18 ± 2.71 | 0.009 | 0.643 | 0.010 | 0.029 |
| Total Score | 5.09 ± 2.80 | 6.76 ± 2.42 | 0.38 ± 0.93 | < 0.001 | 0.942 | < 0.001 | < 0.001 |

BPI Functional interference

Neuropathic Pain

Issues focused on the psychic: ability to walk, relationship with other people, appreciation of the life

Mixed Pain

Issues focused on the physic: General activity, work and sleep

Pain in brachial plexus avulsion

QoL SF-12 physical domain worse in mixed pain patients

Table 7S. Descriptive statistics (mean \pm SD) of the presence of pain according to characteristics of functionality, quality of life and health in patients with BPA.

| Psychological aspects | NP | MP | No Pain | p^* | M x NP p^{**} | M x NoP p^{**} | NP x NoP p^{**} |
|---------------------------------------|-----------------|-----------------|-----------------|--------|--------------------|---------------------|----------------------|
| <i>HADS</i> | | | | | | | |
| Anxiety (0–21) | 7.00 \pm 5.43 | 8.46 \pm 4.16 | 1.15 \pm 1.95 | <0,001 | 0.605 | <0.001 | 0.001 |
| Depression (0–21) | 5.42 \pm 4.76 | 6.88 \pm 3.96 | 1.38 \pm 2.84 | <0,001 | 0.437 | <0.001 | 0.009 |
| <i>Pain catastrophizing scale</i> | | | | | | | |
| Rumination (0–5) | 2.83 \pm 1.97 | 2.58 \pm 1.57 | 0.31 \pm 0.99 | <0,001 | 0.882 | <0.001 | 0.002 |
| Helplessness (0–5) | 2.08 \pm 1.65 | 2.69 \pm 1.30 | 0.23 \pm 0.45 | <0,001 | 0.304 | <0.001 | 0.004 |
| Total (0–5) | 2.46 \pm 1.61 | 2.64 \pm 1.31 | 0,27 \pm 0.70 | <0,001 | 0.899 | <0.001 | 0.002 |
| Quality of life and disability | | | | | | | |
| <i>SF-12</i> | | | | | | | |
| PCS (0–100) | 38.6 \pm 9.70 | 31.2 \pm 7.50 | 51.2 \pm 7.40 | <0,001 | 0.044 | <0.001 | 0.003 |
| MCS (0–100) | 45.9 \pm 13.6 | 47.0 \pm 13.7 | 54.6 \pm 9.52 | 0.173 | 0.899 | 0.393 | 0.118 |
| Quick Dash score (0–100) | 61.5 \pm 22.0 | 66.2 \pm 13.5 | 21.3 \pm 16.6 | <0,001 | 0.919 | <0.001 | <0.001 |

* Kuskal-wallis with **Dwass-Steel-Critchlow-Fligner pairwise comparisons

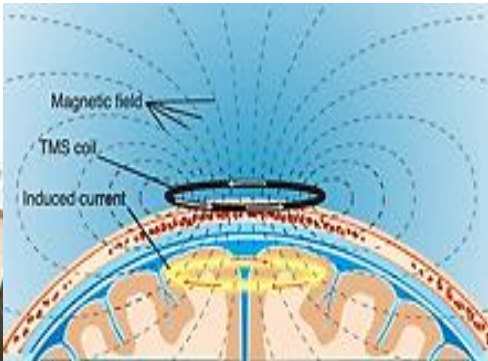
Abbreviations: MP, mixed pain; NP, neurophatic pain; NoP, no pain; HADS: Hospital Anxiety Depression Symptoms; SF-12: Health survey: 12-item questionnaire; PCS: physical component; MCS: mental component

Pain in brachial plexus avulsion

Cortical Excitability

- Contralateral motor cortex TMS induced paresthesias in the affected limb
- Surface area: 2.1 - 42.8 ²cm (mean=10.6 cm²; SD=11.11; median=26.1 cm)

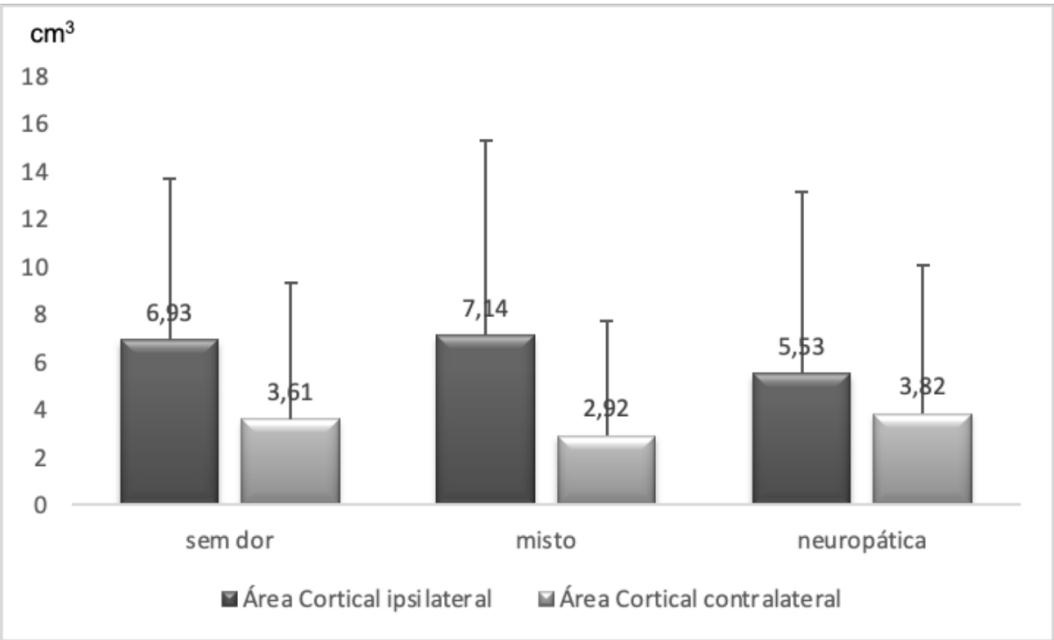
Motor Evoked Potential



- Mixed pain: variation 4.22²cm
- Pain-free group: variation 3.32²cm
- Neuropathic pain: variation 1.71²cm

Gráfico 27. Média das Áreas Corticais (cm³) do cortex motor primário segundo as áreas avaliadas e dor entre os doentes com APB.

| Motor threshold | Positive | | Negative | | Total | |
|-----------------|----------|--------|----------|---------|-------|---------|
| | N | (%) | N | (%) | N | (%) |
| 41 a 50 | 0 | (0,0) | 2 | (100,0) | 2 | (5,7) |
| 51 a 60 | 6 | (50,0) | 6 | (50,0) | 12 | (34,3) |
| 61 a 70 | 4 | (36,4) | 7 | (63,6) | 11 | (31,4) |
| 71 a 80 | 4 | (50,0) | 4 | (50,0) | 8 | (22,9) |
| 81 a 90 | 0 | (0,0) | 2 | (100,0) | 2 | (5,7) |
| Total | 14 | (40,0) | 21 | (60,0) | 35 | (100,0) |



Pain in brachial plexus avulsion

Cortical Excitability

Motor Evoked Potential, Intracortical Inhibition, Reseting Motor Potential, Intracortical Facilitation

| Tipo de Dor | LMR | | | | | PEM 120 | | | | | PEM 140 | | | | |
|-------------|---------------|----------------|-----------------|---------------------|---------------------|-----------------|------------------|------------------|-------|-------|-----------------|----------------|-----------------|--------------------|-------|
| | ipsilateral | contra lateral | trapézio | p* | p** | ipsilateral | contra lateral | trapézio | p* | p** | ipsilateral | contra lateral | trapézio | p* | p** |
| sem dor | [48; 40-52] | [46; 39-61] | [48,5; 45-57] | 0,367 ^a | 0,812 ^a | [228; 22,3-719] | [80,4; 27,2-430] | [53,5; 26,7-129] | 0,588 | 0,380 | [947; 48-1570] | [335; 68-934] | [113; 46-181] | 0,455 | 0,380 |
| com dor | [50; 43-58] | [30; 0-57] | [54; 48-63] | <0,001 ^a | <0,001 ^a | [183; 66,9-487] | [11,2; 0-217] | [93,2; 32,2-170] | 0,003 | 0,725 | [438; 173-967] | [10; 0-520] | [172; 60,5-399] | 0,024 ^a | 0,735 |
| misto | [50; 43,5-58] | [19; 0-54] | [55; 48-64] | 0,002 ^a | <0,001 | [193; 72-515] | [5,6; 0-340] | [85,3; 39,3-167] | 0,037 | 0,922 | [710; 180-1525] | [5; 0-1500] | [241; 62,8-391] | 0,060 | 0,833 |
| neuropático | [50; 43-55] | [30; 0-60] | [53; 48,5-61,5] | 0,097 | 0,033 | [144; 55,9-372] | [21,9; 0-156] | [142; 24,7-172] | 0,064 | 0,489 | [275; 144-587] | [26,3; 0-463] | [126; 52,9-404] | 0,313 ^a | 0,934 |

| Tipo de Dor | Inibição Intracortical | | | | | Facilitação Intracortical | | | | |
|-------------|------------------------|-----------------|------------------|-------|-------|---------------------------|----------------|-----------------|--------|-------|
| | ipsilateral | contralateral | trapézio | p* | p** | ipsilateral | contralateral | trapézio | p* | p** |
| sem dor | [403; 32,5-479] | [121; 46,1-178] | [79,9; 35-120] | 0,033 | 0,677 | [652; 44,9-944] | [320; 124-429] | [99,7; 46-135] | 0,244 | 0,077 |
| com dor | [140; 39-283] | [0; 0-150] | [85,5; 25,8-210] | 0,023 | 0,831 | [226; 103-879] | [0; 0-393] | [140; 47,4-287] | <0,001 | 0,756 |
| misto | [143; 59,3-310] | [12; 0-220] | [96,5; 42,9-240] | 0,136 | 0,643 | [244; 102-1186] | [7,6; 0-694] | [135; 84,8-322] | 0,021 | 0,684 |
| neuropático | [126; 35,4-283] | [0; 0-144] | [76,1; 15,7-140] | 0,057 | 0,890 | [194; 109-601] | [0; 0-192] | [140; 22,1-214] | 0,007 | 0,978 |

Contralateral hemisphere:

↓ MEP120% (p = 0.003), MEP140% (p = 0.024) and RMT (p < 0.001) ICF (p < 0.001).

Mixed pain: MRI (p = 0.002), MEP 120% (p = 0.037), ICF (p = 0.021), statistical trend of MEP 140% (p = 0.060).

Neuropathic pain: ICF (p = 0.007), trend MEP120% (p = 0.064), RMTL (p = 0.097) and ICI (p = 0.057)

Pain in brachial plexus avulsion

Workup

Acute phase of traumatic brachial plexopathy

- Accuracy of the diagnosis in acute phase difficult: anatomy of the plexus, incomplete and complex lesions and injuries
- Diagnosis and estimation the severity of the lesion ► prognostic, surgical, and rehabilitative purposes
- Electrodiagnosis: a mainstay in the diagnostic evaluation after the 3rd week
- Radiographies, computed tomography (bones and othe lesions), magnetic resonance imaging (peripheral nerve structures):
other soft-tissue or bone injuries

Management of traumatic brachial plexopathy

- Goals: preservation of the range of motion (ROM), improve strength, and management of pain
- Surgery: persistence of symptoms and signs despite appropriate conservative treatment
- Reparable injuries: primary reconstruction and debridement and decompression of the nerve issue
- Non-reparable injuries: neurotization or nerve transfers, spinal cord implantation of avulsed spinal nerves *Carlstedt et al. 1995*

Pain in brachial plexus avulsion

Birth-related brachial plexus palsy

- Controversies regarding surgical timing
- Small number of patients require surgical management
- Direct nerve transfers may minimize interpositional grafting procedures

Adult brachial plexus closed injury

- Evaluation of the situation, managing of pain, and starting rehabilitation.
- Advances
 - Diagnostic imaging, electrophysiologic tests
 - Physical therapy and rehabilitation: multidisciplinary approach: improves symptoms and function in children and those with a stretch-type injury/outcome poorer in patients with root avulsions
- Acutely: traumatic mass effect ► prevention of irreversible atrophy of denervated muscles
- Functional restoration: microsurgical early exploration, neurolysis, nerve repair, nerve transfer, nerve grafting, neurotization, free muscle and tendon transfers, nerve rootlet reimplantation,
- Continuity of the nerve fascicles: conservative management
- Preganglionic brachial plexopathy and severe loss of function / multilevel root avulsions not amenable to direct repair: nerve transfer ► restoration of biceps function (C6) and shoulder mobility (C5)
- Post-ganglionic with damaged fascicles: nerve decompression, nerve grafting, excising the damaged plexus segment + nerve autograft with sural, phrenic, spinal accessory, or medial pectoral nerves

Pain in brachial plexus avulsion

No consensus on the analgesic management

Tricyclic antidepressants (amitryptiline) and or antiepileptic drugs

Empirical drug therapy


- Simple analgesics and NSAIDs: no help in the chronic phase
- TADs or serotonin and noradrenaline reuptake inhibitors (SNRIs)
- ADs + anti-epileptic agents (gabapentin, pregabalin, topiramate, carbamazepine, oxcarbazepine lamotrigine)
- Topicals: 5% lidocaine (lignocaine) patches, 8% capsaicine ?
- Opioids: tramadol, tapentadol, morphine, oxycodone, methadone, TD buprenorphine
- Botulinum toxin: post-ganglionic lesion
- Other drugs: cannabinoids, ketamine, clonidine, nefopam, coxibs, pamycin, intrathecal Trichostatin, IV immunoglobulin?
- Electroacupuncture
- Transcutaneous electrical nerve stimulation (TENS)
- Stellate ganglion blocks: CRPS

Pain in brachial plexus avulsion

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Practice guidelines

Pharmacological and non-pharmacological treatments for neuropathic pain: Systematic review and French recommendations



suppl.
Informations

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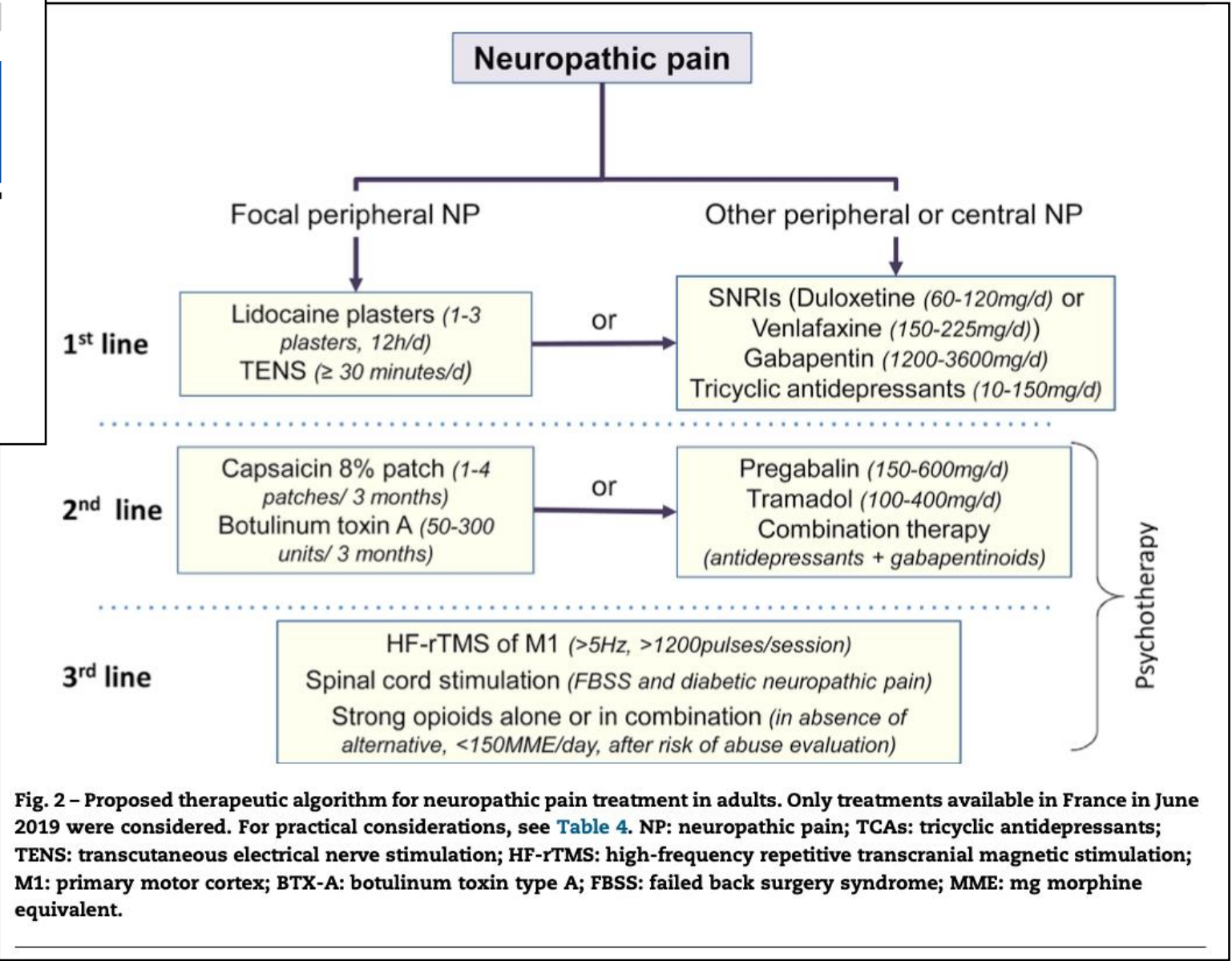


Fig. 2 – Proposed therapeutic algorithm for neuropathic pain treatment in adults. Only treatments available in France in June 2019 were considered. For practical considerations, see Table 4. NP: neuropathic pain; TCAs: tricyclic antidepressants; TENS: transcutaneous electrical nerve stimulation; HF-rTMS: high-frequency repetitive transcranial magnetic stimulation; M1: primary motor cortex; BTX-A: botulinum toxin type A; FBSS: failed back surgery syndrome; MME: mg morphine equivalent.

Pain in brachial plexus avulsion

Surgery

• Restorative surgery

- Brachial plexus injury repair with direct suture, grafts or nerve transfers, minimizes the incidence and severity of neuropathic pain???
- Sooner the repair/ better the result [Berman et al. 1996](#)

• Continuous pain: neuromodulation

- Post-ganglionic lesion: peripheral nerve stimulation: 50–83% ► pain relief: 65–80% of the patients
- Cervical spinal cord stimulation: brachial plexus injuries effective in is 50%, failed previous DREZotomy?
- Pulsed radiofrequency: plexular lesion without avulsion?
- Thalamic and periaqueductal grey matter deep brain stimulation: 55% improvement in BPI and post-amputation pains



?

Pain in brachial plexus avulsion

Dorsal entry zone region lesions

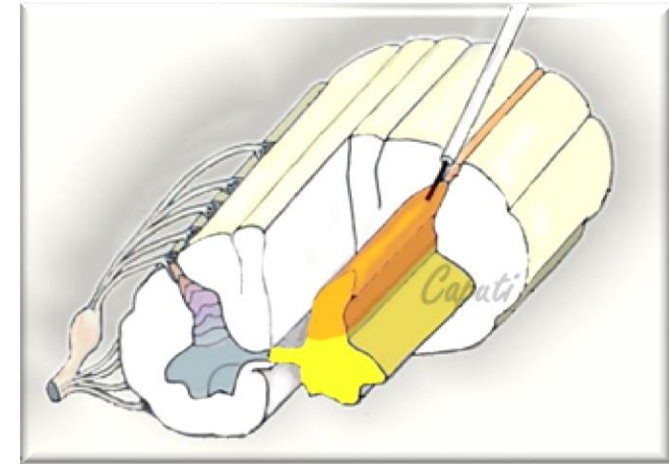
TABLE 3. Percentage Pain Relief at Final Follow-up for Patients Receiving DREZ Lesioning for BPA

| Lesioning method | Reference | No. of BPA patients | Degree of pain relief at final follow-up (%) | | | |
|---|--|---------------------|--|------------|---------------------|--------------------|
| | | | 75% to 100% | 50% to 75% | 25% to 50% | <25% |
| MDT | Jeanmonod and Sindou, 1991 ⁴⁷ | 3 | 67% | 0% | 33% | 0% |
| MDT | Emery et al, 1997 ⁸ | 37 | 65% | | 27% | 8% |
| MDT | Guenot et al, 2003 ² | 9 | 44% | 22% | 11% | 22% |
| MDT | Sindou et al, 2005 ⁷ | 55 | 38% | 31% | 31% | 0% |
| MDT ^a | Prestor, 2006 ¹³ | 26 | 76% (12% "complete") | | 24% | |
| MDT | Zheng et al, 2009 ⁴⁵ | 14 | 64% | | 36% | |
| MDT | Aichaoui et al, 2011 ⁴ | 29 | 59% | 24% | 7% | 10% |
| MDT | Dong et al, 2012 ⁴⁹ | 7 | 100% | 0% | 0% | 0% |
| RF | Nashold and Ostdahl, 1979 ¹⁵ | 18 | 56% | | 17% | 28% |
| RF | Thomas and Sheehy, 1983 ⁵³ | 19 | 52% | | 32% | 16% |
| RF | Richter and Seitz, 1984 ⁵⁴ | 7 | 71% | 0% | 0% | 29% |
| RF | Samii and Moringlane, 1984 ¹⁶ | 22 | 77% ^c | | 14% ^c | 9% |
| RF | Thomas and Jones, 1984 ⁵⁵ | 34 | 59% | | 26% | 15% |
| RF ^b | Bruxelle et al, 1988 ¹⁹ | 18 | 83% | 17% | 0% | 0% |
| RF | Campbell et al, 1988 ⁶⁰ | 10 | 80% | 20% | 0% | 0% |
| RF | Friedman et al, 1988 ⁹ | 39 | 54% | 13% | 0% | 33% |
| RF | Ishijima et al, 1988 ³⁸ | 19 | 82% | 18% | 0% | 0% |
| RF | Young, 1990 ³⁶ | 18 | 75% | | | 25% |
| RF | Kumagai et al, 1992 ⁵⁰ | 7 | 29% | 14% | 57% | 0% |
| RF | Thomas and Kitchen, 1994 ¹² | 44 | 68% | | 11% | 21% |
| RF | Fazl et al, 1995 ⁶² | 4 | | 100% | 0% | |
| RF | Rath et al, 1997 ⁵⁸ | 23 | 57% | | 26% | 17% |
| RF | Samii et al, 2001 ¹⁰ | 47 | 63% | | 37% | 0% |
| RF | Tomáš and Haninec, 2005 ⁵⁷ | 21 | 62% | | 38% | 0% |
| RF | Ali et al, 2011 ¹⁴ | 11 | 55% (P) 27% (C) | | 18% (P) 0% (C) | 27% (P) 73% (C) |
| RF | Awad et al, 2013 ³⁴ | 10 | 60% (30% "complete") | | 40% (30% no relief) | |
| RF | Haninec et al, 2014 ⁵⁹ | 52 | 71% | 21% | | 8% |
| Laser | Powers et al, 1984 ⁶⁵ | 2 | 100% | 0% | | 0% |
| Laser | Powers et al, 1988 ⁶⁴ | 6 | 100% | 0% | | 0% |
| Laser | Young, 1990 ³⁶ | 4 | 50% | | 50% | |
| US | Dreval, 1993 ⁶⁸ | 124 | 87% | | 13% | |
| Various | Ko et al, 2016 ⁶¹ | 15 | 33% (13% "complete") | 33% | | 33% |
| Total/Average for all modalities | | 754 | 75.7% | | 24.3% | |

C, continuous pain component; MDT, microsurgical DREZotomy; P, paroxysmal pain component; RF, radiofrequency; US, ultrasound.

^aModified procedure not incorporating microknife incision.

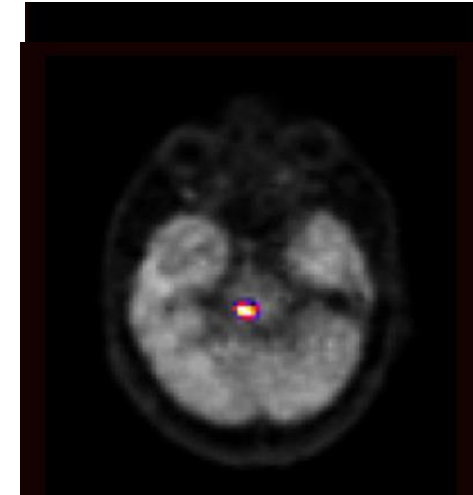
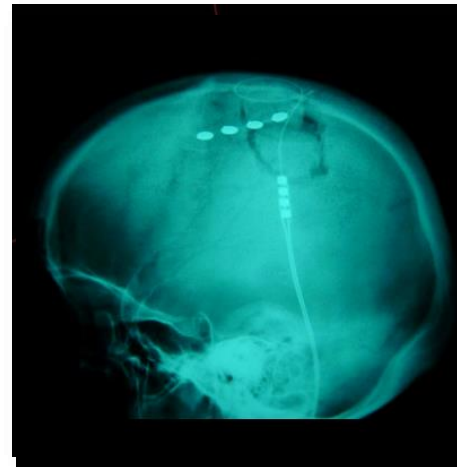
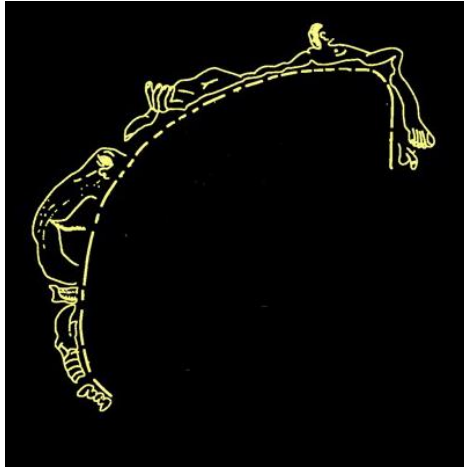
^bModified procedure also incorporating microblade lesioning of cord.



- **Paroxysmal painful discharges: ablative procedures**
- DREZotomy: 50–75% of the paroxysmal pain
less in inconstant pain/10% of patients
- Complications: ipsilateral lower limb weakness and ataxia,
- 13–20% recurrence (constant pain)
- Final FU acceptable pain control in 60%

Pain in brachial plexus avulsion

Motor cortex stimulation



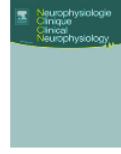
| Authors/years | Type of pain | N | Improvement (%) | Follow up (m) |
|-----------------------|--------------------------------|----|-----------------|---------------|
| Tsubokawa et al. 1991 | Central pain | 12 | 75 | 2 |
| Nguyen et al. 2000 | Neuropathic pain | 13 | 77 | |
| Teixeira et al. 1996 | Neuropathic pain | 9 | 66 | 18 |
| Meyerson 1993 | Peripheral neuropathic pain | 6 | 50 | |
| Katayama et al. 2001 | Neuropathic pain | 9 | 48 | |
| Rainov et al. 1997 | Facial pain | 2 | 100 | 18 |
| Nguyen et al. 1999 | Facial pain | 12 | 83 | 27 |
| Teixeira et al. 1998 | Facial pain | 3 | 67 | 32 |
| Nguyen et al. 2000 | Myelopathic pain | 3 | 33 | |
| Katayama et al. 1994 | Wallerberg's syndrome | 3 | 66 | 6 |
| Teixeira et al. 2006 | BPA | 8 | 83 | 8 |
| Katayama et al. 2001 | Phantom limb pain | 5 | 20 | |
| Teixeira et al. 2006 | Complex regional pain syndrome | 2 | 100 | 14 |

Pain in brachial plexus avulsion



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Into the Island: A new technique of non-invasive cortical stimulation of the insula

Operculo-insular cortex TMS stimulation

Targeting the insula

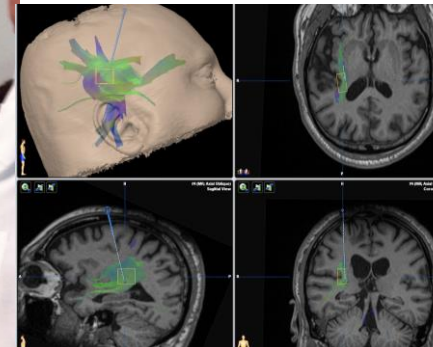
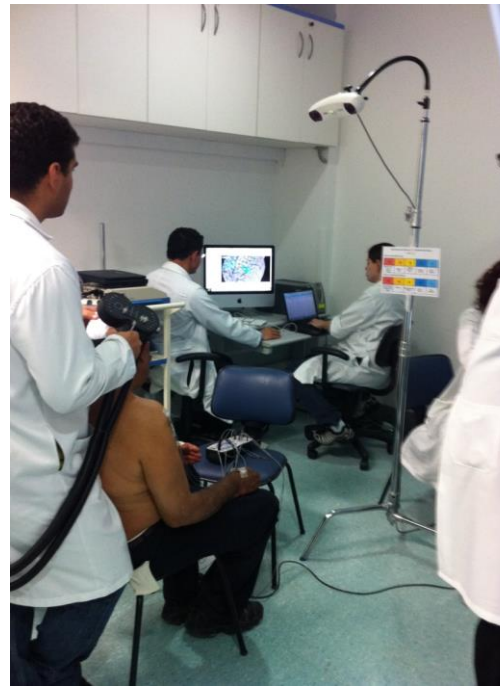
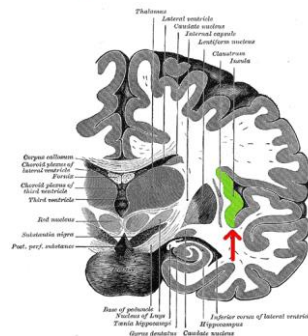
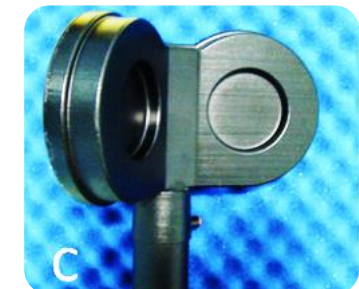
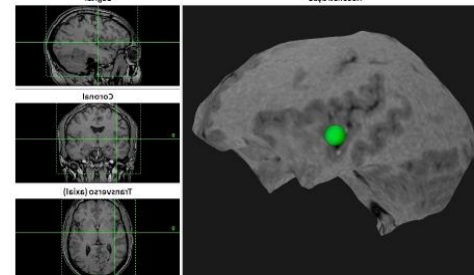
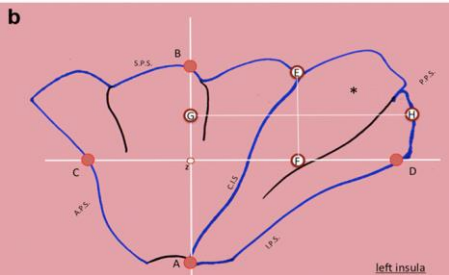
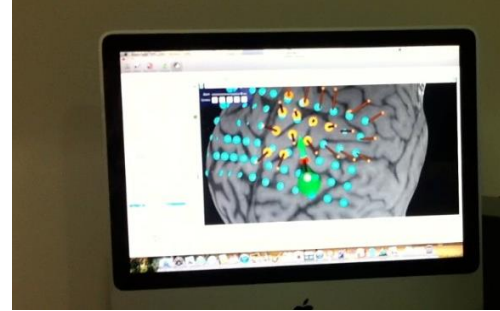
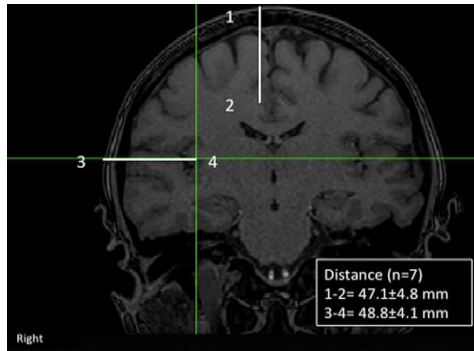
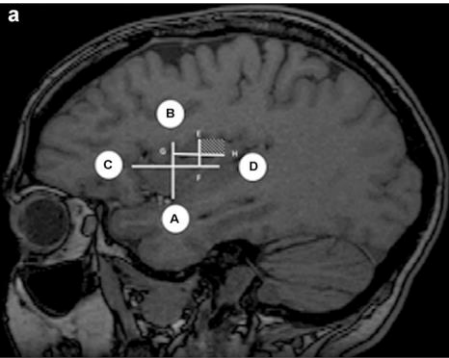
- Did not affect thermal detection thresholds or heat pain thresholds/baseline values
- Cold pain threshold decreased (towards analgesia) 1 hour after the stimulation ns

Postero-superior insula TMS

Table 1 Thermal thresholds measured by quantitative sensory testing and distances from the scalp to targets.

| Distances and thresholds | N | Minimum | Maximum | Mean | Std. Deviation | Related samples Wilcoxon's Signed Rank Test (P) |
|--|---|---------|---------|--------|----------------|---|
| RMT_TA (%MSO) | 7 | 39 | 83 | 54.43 | 16.092 | |
| Distance between skull and insula (mm) | 7 | 43.0 | 53.7 | 48.814 | 4.1755 | 0.240 |
| Distance between skull and LL M1 (mm) | 7 | 38.3 | 51.8 | 47.114 | 4.8057 | |
| CDT_LUP_B (°C) | 7 | 22.4 | 30.8 | 29.214 | 3.0394 | 0.396 |
| CDT_LUP_A (°C) | 7 | 26.0 | 30.7 | 28.871 | 1.8200 | |
| WDT_LUP_B (°C) | 7 | 32.9 | 39.3 | 34.871 | 2.1523 | 0.093 |
| WDT_LUP_A (°C) | 7 | 33.1 | 36.4 | 33.900 | 1.1460 | |
| HPT_LUP_B (°C) | 7 | 39.5 | 46.8 | 43.529 | 2.8582 | 0.396 |
| HPT_LUP_A (°C) | 7 | 39.8 | 48.2 | 44.029 | 3.1495 | |
| CPT_LUP_B (°C) | 7 | 9.7 | 25.2 | 17.957 | 5.4052 | 0.061 |
| CPT_LUP_A (°C) | 7 | 3.8 | 20.3 | 12.543 | 6.1321 | |

CDT: cold detection threshold; WDT: warm detection threshold; HPT: heat pain threshold; CPT: cold pain threshold; LUP: left upper limb; LL: lower limb; M1: primary motor cortex; B: baseline; A: after; RMT: rest motor threshold; TA: tibialis anterior muscle; MSO: maximal stimulator output.

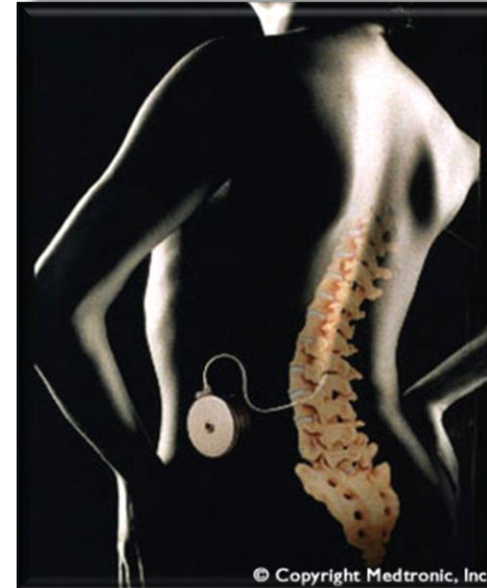
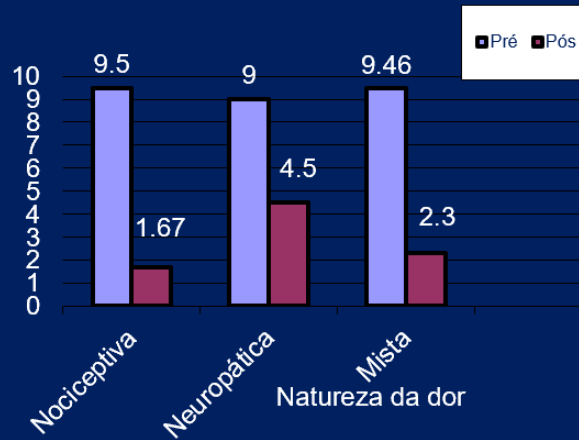


Pain in brachial plexus avulsion

Intrathecal infusion of drugs

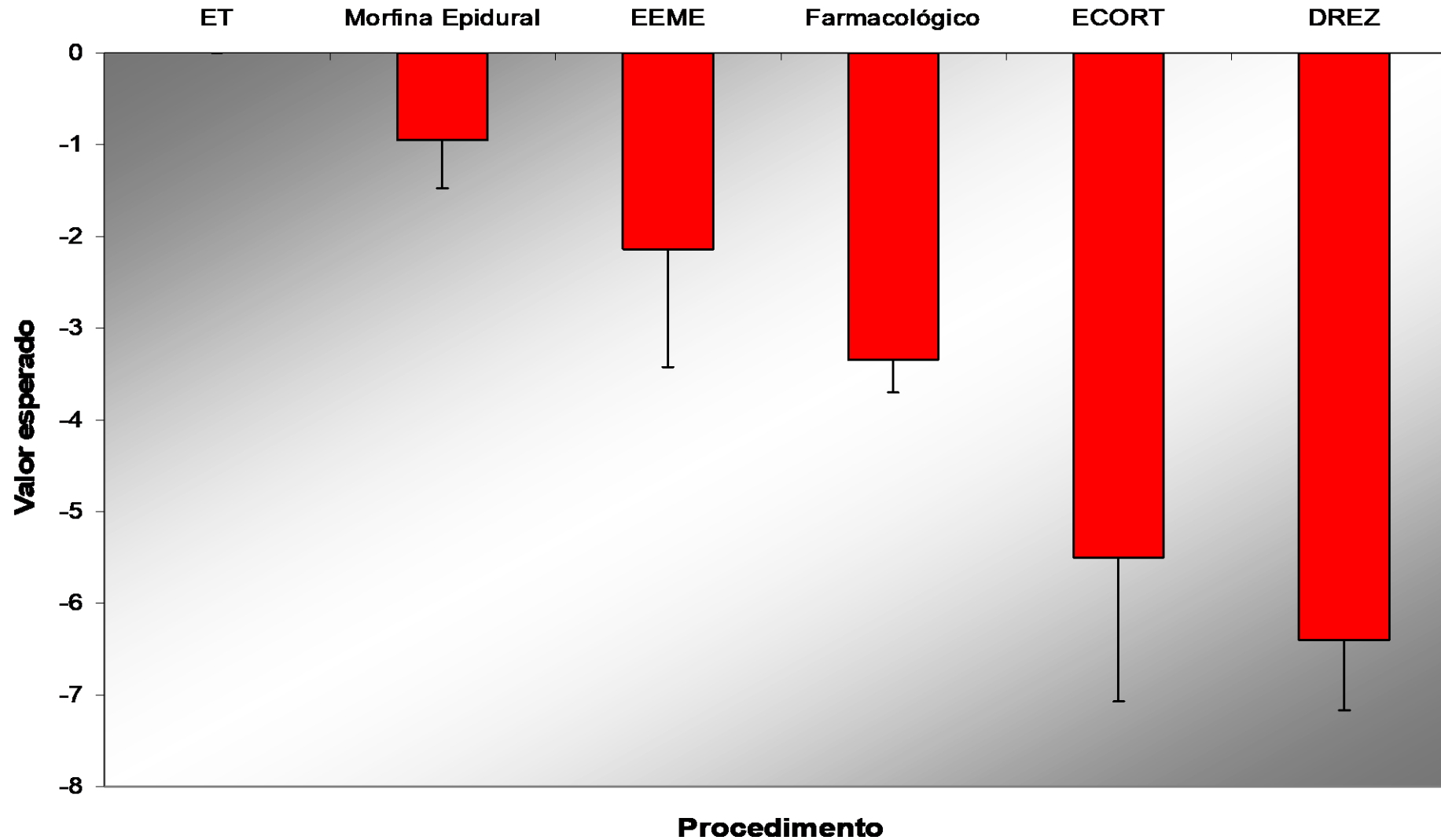
Drugs: opioids, Ca^{++} channel antagonists, NMDA antagonists, GABA agonists, alpha-2-adrenergic agonists, acetylcholinesterase inhibitors and somatostatin analogue

ENV da dor pré e pós tratamento da dor com infusão intraspinal de morfina durante mais de 18 meses n=88



Pain in brachial plexus avulsion

Expected values and standard errors of variations in the VAS pain score for each procedure



Pain in brachial plexus avulsion

Conclusions

- Neuropathic pain is very frequent in patients with brachial plexus injury,
- Several mechanisms: peripheral nociceptor sensitization, peripheral ectopic discharges, central sensitization in the dorsal horn, and cortical reorganization, sensitization and neuroplasticity.
- Pain severity similar in patients with mixed pain and neuropathic pain
- The impact on pain sensations, mood, quality of life and physical disability higher on the mixed pain patients
- The impact in the physical components higher than in the psychic and mental dimensions in mixed pain patients
- The disability is greater for bi-manual skills, strength, and sleep in mixed pain patients
- There are differences in the cortical plasticity between neuropathic and mixed pain patients
- Treatment: pharmacological measures, non-pharmacological strategies, topical agents, physiotherapy, and rehabilitation programs
- Surgical options: nerve repair or nerve transfer, DREZ, spinal cord stimulation for non-avulsion neuropathic pain, cortical and posterior insula stimulation for constant pain