

Neurological complications in diabetic children

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Complications of diabetes mellitus

◆ Acute complications:

- Ketoacidosis
- The hyperglycemic hyperosmolar nonketotic syndrome
- Hypoglycemia

◆ Chronic complications:

- Disorders of the microcirculation
 - ◆ Neuropathies
 - ◆ Nephropathies
 - ◆ Retinopathies
- Macrovascular complications
- Foot ulcers

Complications of DKA

Cerebral edema

- Typically occurs 4 -12 hrs after starting treatment
- Risk 7 / 1000 episodes of DKA
- 12 / 1000 episodes of DKA in new IDDM
- 24% morbidity
- 35% left with significant morbidity

Why does it happen?

- No one really knows!
- Numerous mechanisms proposed
 - Cerebral hypoxia
 - Drop in plasma osmolality
 - Generation of inflammatory mediators
 - Disruption of cell membrane ion transport
 - Aquaporin channels
 - Generation of intracellular organic osmolytes causing influx water into brain cells

Risk factors for cerebral edema

- Younger child
 - Newly diagnosed Diabetes
- } at highest risk
- Lower pH
 - High urea
- } at presentation
- **Administration of insulin within 1st hour**
 - **Administration of bicarbonate**
 - **Administration of large volumes of fluid in the 1st 4 hours of treatment**

Cerebral edema

- Symptoms

- **Headache**
- Drowsiness
- Incontinence
- Vomiting recurrence

- Signs

- Decreased consciousness
- Bradycardia
- Rising BP
- Decreasing O₂ sats
- Neurological signs
- Abnormal pupil responses
- Abnormal posturing

Treatment of cerebral edema

- ◆ Mannitol 0.5g to 1.5g / kg (= 2.5 to 7.5ml / kg 20% Mannitol) over 30mins
- ◆ 3% saline

The hyperglycemic hyperosmolar nonketotic (HHNK) syndrome

- ◆ In hyperosmolar states, the increased serum osmolarity has the effect of pulling water out of body cells, including brain cells. The condition may be complicated by thromboembolic events arising because of the high serum osmolality.
- ◆ The most prominent **manifestations** are dehydration:
 - Neurologic signs and symptoms:
 - ◆ Grand mal seizures
 - ◆ Hemiparesis
 - ◆ Aphasia
 - ◆ Muscle fasciculations
 - ◆ Hyperthermia
 - ◆ Visual field loss
 - ◆ Nystagmus
 - ◆ Visual hallucinations
 - Excessive thirst
- ◆ The onset of HHNK syndrome often is insidious, and it may be mistaken for a stroke.

Hypoglycemia

- ◆ Because the brain relies on blood glucose as its main energy source, hypoglycemia produces behaviors related to altered cerebral function:
 - Headache
 - Difficulty in problem solving
 - Disturbed or altered behavior
 - Coma
 - Seizures
- ◆ At the onset of the hypoglycemic episode, activation of the parasympathetic nervous system often causes hunger.
- ◆ The initial parasympathetic response is followed by activation of the sympathetic nervous system; this causes anxiety, tachycardia, sweating, and constriction of the skin vessels (*i.e.*, the skin is cool and clammy).

Hypoglycaemia symptoms & signs

hunger

coma

pins & needles

anxiety

abdominal pain

headache

palpitations

weakness

nausea & vomiting

tremor

blurred vision

fainting

dizziness

abnormal

confusion

convulsions

cry

irritability

apnoea

hypotonia

Hypoglycaemia management

◆ Conscious

- 10g fast carbohydrate followed by starchy snack

◆ Conscious but unco-operative

- Glucogel followed by starchy snack

◆ Unconscious

- Glucagon then starchy snack if possible & hospital

Neuropathy

- ◆ When present, neuropathy is mostly subclinical in children.
- ◆ While prospective nerve conduction studies and autonomic neuropathy assessment studies have demonstrated increased prevalence of abnormalities over time, persistence of abnormalities is an inconsistent finding
- ◆ Vibration and monofilament testing have suboptimal sensitivity and specificity in adolescents
- ◆ With the exception of intensifying diabetes management to achieve and maintain glycemic targets, no other treatment modality has been studied in children and adolescents.

Neuropathy

- ◆ Diabetic neuropathy can present as mononeuropathy or polyneuropathy and can also be divided in sensory, motor and autonomic.
- ◆ The pathogenesis is not well elucidated, but it is believed that the mononeuropathies, such as the acute cranial nerve palsies and diabetic amyotrophy, are due to ischemic infarction of the peripheral nerves.
- ◆ The peripheral sensori-motor neuropathies and autonomic neuropathies may be caused by a metabolic factor or osmotic toxicity secondary to hyperglycemia.

Pathophysiology of Chronic Complications

Macrovascular Complications

- Main cause of mortality
- large and medium vessel disease due to accelerated atherosclerosis

Microvascular Complications

- Significant source disability and decrease in quality of life
- Capillary dysfunction in target organs

Peripheral neuropathies

- ◆ Two types of pathologic changes have been observed in connection with diabetic peripheral neuropathies.
 - The first is a thickening of the walls of the nutrient vessels that supply the nerve, leading to the assumption that vessel ischemia plays a major role in the development of these neural changes.
 - The second finding is a segmental demyelination process that affects the Schwann cell. This demyelination process is accompanied by a slowing of nerve conduction.
- ◆ The clinical manifestations of the diabetic peripheral neuropathies vary with the location of the lesion.

Classification of diabetic peripheral neuropathies

◆ Somatic:

- Polyneuropathies (bilateral sensory)
 - ◆ Paresthesias, including numbness and tingling
 - ◆ Impaired pain, temperature, light touch, two-point discrimination, and vibratory sensation
 - ◆ Decreased ankle and knee-jerk reflexes
- Mononeuropathies
 - ◆ Involvement of a mixed nerve trunk that includes loss of sensation, pain, and motor weakness.
- Amyotrophy
 - ◆ Associated with muscle weakness, wasting, and severe pain of muscles in the pelvic girdle and thigh.

◆ Autonomic:

- Impaired vasomotor function
 - ◆ Postural hypotension
- Impaired gastrointestinal function
 - ◆ Gastric atony
 - ◆ Diarrhea, often postprandial and nocturnal
- Impaired genitourinary function
 - ◆ Paralytic bladder
 - ◆ Incomplete voiding
 - ◆ Impotence
 - ◆ Retrograde ejaculation
- Cranial nerve involvement
 - ◆ Extraocular nerve paralysis
 - ◆ Impaired pupillary responses
 - ◆ Impaired special senses

Sensorimotor Neuropathy

- ◆ Patients may be asymptomatic / complain of numbness, paresthesias, or pain
- ◆ Feet are mostly affected, hands are seldom affected
- ◆ In Diabetic patients sensory neuropathy usually predominates

Complications of Sensorimotor neuropathy

- ◆ Ulceration (painless)
- ◆ Neuropathic edema
- ◆ Arthropathy



Screening for Neuropathy



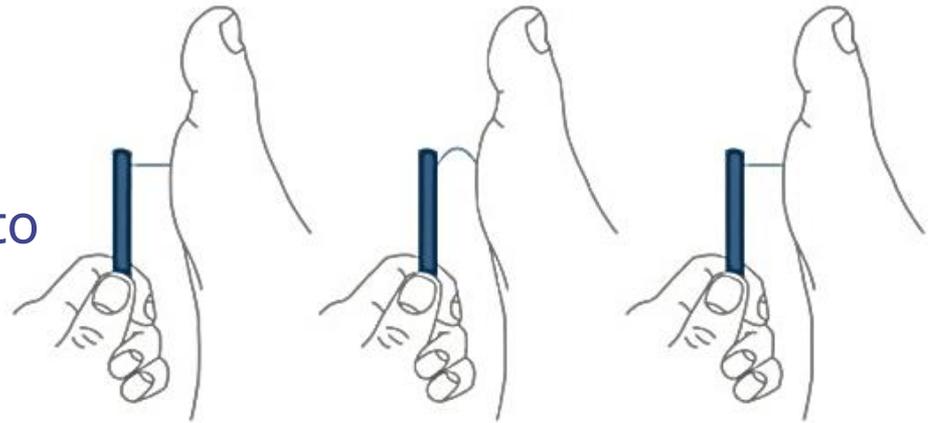
- ◆ 128 Hz tuning fork for testing of vibration perception
- ◆ Semmners monofilament

The main reason is to identify patients at risk for development of diabetic foot

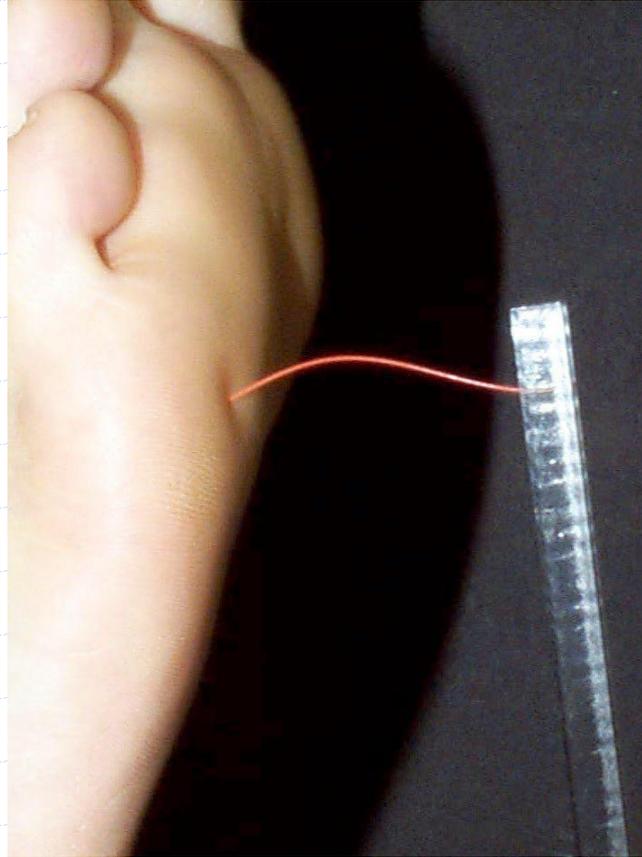
Recommendations: Foot Care

monofilament test, place the device perpendicular to the skin, with pressure applied until the monofilament buckles

- Hold in place for 1 second and then release
- The monofilament test should be performed at the highlighted sites while the patient's eyes are closed



Using of the Monofilament



Recommendations: Pediatric Neuropathy (Type 1 Diabetes)

- ◆ Consider an annual comprehensive foot exam for the child at the start of puberty or at age ≥ 10 years, whichever is earlier, once the youth has had type 1 diabetes for 5 years

Proximal Motor Neuropathy

Amyotrophy – most common proximal neuropathy, affects the Quadriceps muscles with weakness and atrophy (synonym: Diabetic Femoral radiculoneuropathy)

Mononeuropathies

Cranial nerve palsies (most common are n. IV, VI, VII)

Truncal neuropathy (rare)

Entrapment Neuropathies

- ◆ Carpal tunnel syndrome (median nerve)
- ◆ Ulnar compression syndrome
- ◆ Meralgia paresthetica (lat cut nerve to the thigh)
- ◆ Lat Popliteal nerve compression (drop foot)

All the above are more common in diabetic patients

Autonomic Neuropathy

Symptomatic

Postural hypotension

Gastroparesis

Diabetic diarrhea

Neuropathic bladder

Erectile dysfunction

Neuropathic edema

Charcot arthropathy

Gustatory sweating

Subclinical abnormalities

Abnormal pupillary reflexes

Esophageal dysfunction

Abnormal cardiovascular
reflexes

Increased peripheral blood
flow

Recommendations: Neuropathy Screening, Treatment

- ◆ All patients should be screened for distal symmetric polyneuropathy
- ◆ At diagnosis of type 2 diabetes and 5 years after diagnosis of type 1 diabetes
 - At least annually thereafter using simple clinical tests, such as a monofilament
- ◆ Screening for signs and symptoms of cardiovascular autonomic neuropathy
 - Should be considered with more advanced disease



◆ postpubertal children with type 1 diabetes of >5 years' duration and poor metabolic control should be questioned about symptoms of numbness, pain, cramps and paresthesia, and examined for skin sensation, vibration sense, light touch and ankle reflexes

Recommendations: Neuropathy Screening, Treatment

- ◆ Tight glycemic control is the only strategy
 - To prevent or delay the development of distal symmetric polyneuropathy in patients with type 1 diabetes
 - To slow the progression of neuropathy in some patients with type 2 diabetes
- ◆ Assess and treat patients
 - To reduce pain related to DPN
 - To reduce symptoms of autonomic neuropathy
 - To improve the quality of life

Summary

- ◆ Diabetic neuropathy is a common complication, and result in significant morbidity
- ◆ Diabetic neuropathy present in numerous ways
- ◆ Hyperglycemia is the cause of diabetic neuropathy

Summary (cont)

- ◆ Diabetic neuropathy have bad consequences
- ◆ Once diabetic neuropathy is present it can only be managed symptomatically
- ◆ Early diagnosis and aggressive management can prevent progression

Psychosocial problems

- Psychosocial problems are very common among children with diabetes and their families.
- Up to half of children develop depression, anxiety, or other psychologic problems
- Eating disorders are a serious problem in adolescents, who sometimes also skip insulin doses in an effort to control weight.
- Psychosocial problems can also result in poor glycemic control by affecting children's ability to adhere to their dietary and/or drug regimens.



◆ Children and adolescents with diabetes, along with their families, should be screened regularly for psychosocial or psychological disorders and should be referred to an expert in mental health and/or psychosocial issues for intervention when required

