Diabetes Mellitus and Surgery
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Diabetes Mellitus is an endocrine disorder affecting body metabolism, which changes the response of tissue to external or internal injury.
A Diabetic patient should not be denied surgery because he is diabetic.

Every patient is surgical diabetic at least once in his lifetime.
Classification & Diagnosis

- Classification
- Diagnostic Tests for Diabetes
- Prediabetes
- Type 1 Diabetes
- Type 2 Diabetes
- Gestational Diabetes
- Monogenic Diabetes Syndromes
- Cystic Fibrosis-Related Diabetes

1. Type 1 diabetes
   - $\beta$-cell destruction
2. Type 2 diabetes
   - Progressive insulin secretory defect
3. Gestational Diabetes Mellitus (GDM)
4. Other specific types of diabetes
   - Monogenic diabetes syndromes
   - Diseases of the exocrine pancreas, e.g., cystic fibrosis
   - Drug- or chemical-induced diabetes

Protean manifestation

Basic pathology-microangiopathy

Vessels:
- Vascular insufficiency, C.V.A.,
- Predisposes atherosclerosis

Kidney:
- KW Syndrome’ Interstitial Glomerulonephritis

Retina:
- Diabetic Retinopathy, Cotton Wool,
- Flame shaped H’ages
- Predisposes retinal detachment

Pregnancy: Big baby syndrome, Obstruct labor.
Fibrin thrombi extending from glomerulus into arteriole in thrombotic microangiopathy (Jones’ silver stain) – Agnes Fogo
Surgical conditions produced or aggravated in Diabetes mellitus
Surgical conditions modified in DM
Diabetes mellitus producing diagnostic problems
Surgery in Diabetics
Surgery for relief of Diabetes Mellitus
Surgical conditions either produced or aggravated by D M

- Septic lesions
- Neuropathic lesions
- Ischemic lesions
- Mixed
Surgical conditions produced or aggravated

- a) Septic lesions
  - Presenting feature of uncontrolled D M rapid course
  - Aggravates diabetic pathology
  - Converts a potential D M / Manifest D M
  - Fulminating infection
  - Diminished cellular resistance.
Septic conditions

- Cellulitis, carbuncle, Abscess, furunculosis, infective gangrene, osteomyelitis, urinary tract infections,
- Respiratory tract infection
- Sequele Fast action
  - Blister – Cellulitis – Tenosynovitis
  - Osteomyelitis – infective thrombosis
  
Wet gangrene
Neuropathic lesions

Nervous system cannot metabolize anything except carbohydrates

- Sugar utilization at tissue
- Defects in nerve conduction
  peripheral neuritis
Diabetic neuropathy

- Hyperglycemia
- Dyslipidemia
- Metabolic syndrome
- Impaired insulin signaling
- Growth factor deficiency
- Vascular deficiency
- Neurovascular interaction
Presentation depends upon type of nerve involved:

- **Sympathetic**: Flushing of face
  - Abnormal vasomotor response
- **Superficial**: Painless perforating
  - Sensory: Trophic ulcer over pressure point
- **Deep Sensory**: Diabetic form of Charkot joint
- **Motor**: Unbalanced paralysis
  - Clawing of hand
  - Usually combined features
Basic lesion of microangiopathy- Combined with Atherosclerosis
Two types:
- **Progressive vascular occlusion**
  - Intermittent claudication
  - Dry gangrene
- **Sudden Vascular occlusion**
  - Ischemic thrombosis in Septic lesions
  - Embolism.
Major Complications of Diabetes

**Microvascular**

**Eye**
High blood glucose and high blood pressure can damage eye blood vessels, causing retinopathy, cataracts and glaucoma.

**Kidney**
High blood pressure damages small blood vessels and excess blood glucose overworks the kidneys, resulting in nephropathy.

**Neuropathy**
Hyperglycemia damages nerves in the peripheral nervous system. This may result in pain and/or numbness. Feet wounds may go undetected, get infected and lead to gangrene.

**Macrovascular**

**Brain**
Increased risk of stroke and cerebrovascular disease, including transient ischemic attack, cognitive impairment, etc.

**Heart**
High blood pressure and insulin resistance increase risk of coronary heart disease.

**Extremities**
Peripheral vascular disease results from narrowing of blood vessels increasing the risk for reduced or lack of blood flow in legs. Feet wounds are likely to heal slowly contributing to gangrene and other complications.
Septic lesion
Neuropathic lesion
Vascular lesion: Diabetic vascular lesion
- Atherosclerosis
- Increased Cholesterol
Diabetic factors affecting healing
- Diabetic Gangrene
- Non healing ulcer.
Grade IV: partial gangrene

Ulcer with lymphedema
Surgical management of infection

- **Conservative Approach**
- **To reduce focus of infection** –
  - Drainage of abscess
  - Amputation
    - Conservative level
    - Line of demarcation not well
    - Guillotine amputation
    - Stroke – Grittis operation
  - Silber's technique

  Infection controlled
  - Planned surgery
  - Healing of ulcer, Skin grafting
Management

1) Switch over to crystalline insulin
2) Aggressive management of infection
   - Vicious cycle of infection and insulin.
   - Insulin requirement goes down decreases infection
   - Insulin adm. Titrating urine/ blood sugar daily
   - Hypoglycemia more dangerous than hyperglycemia
   - More diabetic die of hypoglycemia.
D.M AND SURGERY

Surgical conditions produced or aggravated in Diabetes mellitus

Surgical conditions modified in DM

Diabetes mellitus producing diagnostic problems

Surgery in Diabetics

Surgery for relief of Diabetes Mellitus
Surgical conditions modified by D.M.

- Boil,
- carbuncle,
- osteoporosis,
- Perinephric abscess,
- Gall stones,
- acute appendicitis,
- Koch’s
Surgical conditions modified by Diabetes

- Boil, Carbuncles  Take serious form
- Acute Appendicitis  Fulminant form
  brief acute phase  no signs Masked.
Perforation, Diabetic Ketoacidosis

- Gall Stones  More common, cholesterol high
  Acute cholecystitis, fatal perforation

- Osteoporosis
  - -ve nitrogen balance
  - convulsion
  - fractures,
  - Delayed union

- Tuberculosis  Resistant
Surgical conditions produced or aggravated in Diabetes mellitus

Surgical conditions modified in DM

Diabetes mellitus producing diagnostic problems

Surgery in Diabetics

Surgery for relief of Diabetes Mellitus
Diabetic Abdomen

- It is a syndrome complex characterized by severe pain, diffuse, indefinite vomiting etc. in absence of any abdominal pathology.
- It may be one of the presentations of diabetic keto-acidosis
- Unwarranted Surgery High mortality
<table>
<thead>
<tr>
<th>Acute Abdomen in known diabetic</th>
<th>Diabetic Abdomen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever + or</td>
<td>Usually febrile</td>
</tr>
<tr>
<td>Leucocytosis + or</td>
<td>Increased</td>
</tr>
<tr>
<td>Pattern: Pain</td>
<td>Fever, Vomiting, Pain</td>
</tr>
<tr>
<td>Vomiting – Fever</td>
<td>Diffuse-indefinite</td>
</tr>
<tr>
<td>Pain +</td>
<td>Disproportionate G.C.</td>
</tr>
<tr>
<td>over inflamed viscous</td>
<td>to abdominal findings.</td>
</tr>
</tbody>
</table>
D.M AND SURGERY

1. Surgical conditions produced or aggravated in Diabetes mellitus
2. Surgical conditions modified in DM
3. Diabetes mellitus producing diagnostic problems
4. Surgery in Diabetics
5. Surgery for relief of Diabetes Mellitus
Known diabetic undergoing surgery
D M detected in post-operative period
Emergency surgery in Diabetic Ketoacidosis.
General Anesthesia suppresses endogenous insulin secretion
Vasoactive substances can exert anti-insulin effects
In DM, insulinopenia leads to hyperglycemia, increased osmolality, hypovolemia, abnormal electrolytes, and in extreme DKA or HONK
Other concerns beyond insulin:

- CAD
- Autonomic neuropathy
- Peripheral neuropathy
- Diabetic nephropathy
- Wound healing
- Infections
Complications of Diabetes

Diabetic Retinopathy
Leading cause of blindness in adults¹,²

Diabetic Nephropathy
Leading cause of end-stage renal disease³,⁴

Stroke
2- to 4-fold increase in cardiovascular mortality and stroke⁵

Diabetic Neuropathy

8/10 individuals with diabetes die from CV events⁶
General Principles:

- Surgical stress & strain - Glucocorticoids, Hyperglycemia, Acidosis
- Starvation, Ketoacidosis

Anesthesia factors
- Chloroform; Ether-Increases 10-50mg CHO (No more used)
- Ketamine also increases BSL
- Trichlorethylene (No more used), Halothane safe
- Propofol and Pentothal,
  - Isoflurane, sevoflurane and Desflurane used and safe

Additional coronary-cerebral, renal pathology
Increased incidence of thrombophlebitis, pulmonary embolism, pulm. edema
Poor healing in diabetes

- Presence of excess glucose in wound
- -- Proliferation of micro-organism
- Phagocytic power of PMNL decreases complement
- Blood supply 
  micro angiopathy
  Atherosclerosis
- Nerve Supply 
  Vasomotor Tone
- Supply of insulin essential for healing
Spectrum of Oral Hypoglycaemic Agents

- **Biguanides**: Metformin (Biguanides)
- **Sulphonylureas**: Glibenclamide, Gliclazide, Glipizide, Glimepiride
- **α-Glucosidase inhibitors**: Acarbose
- **Meglitinides**: Repaglinide, Nateglinide
- **Thiazolidinediones**: Rosiglitazone, Pioglitazone
- **Gliptins (DPP4 inhibitors)**: Sitagliptin, Vildagliptin
Oral Hypoglycemic Agents the need to continue……

Metformin……traditional phobia of lactic acidosis: some stop 48 hours before any surgery. Definitely: septic state, hypotension, Renal or any major organ failure. No increased risk if hypoglycemia when used alone.

Sulphonylureas/ Meglitinides Thiazolidinediones…..May be continued.
Acarbose: Avoid due to GI side effects

DPP4 inhibitors: Avoid on the day of surgery because of delayed gastric emptying
## Known diabetic undergoing planned surgery

<table>
<thead>
<tr>
<th>Previous Treatment</th>
<th>Minor</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>Observe</td>
<td>Observe. May need insulin P.O.</td>
</tr>
<tr>
<td>Oral</td>
<td>) Withheld</td>
<td>Switch over to cry. Insulin -do----</td>
</tr>
<tr>
<td>Insulin</td>
<td>) until surgery</td>
<td></td>
</tr>
</tbody>
</table>

- **>140 mg Insulin in drip**
- **<100 mg I.V. Dextrose**
Known Diabetic undergoing planned Surgery

- Take it seriously
- Admit one week prior to surgery
- Assess his diabetic status
- Glycosylated Hemoglobin
- Controlled at least two days prior
- Assessment of cardiac, pulmonary, cerebral and renal status
- After control, Insulin management depending upon magnitude of surgery
The Alberti regimen

- Infusion of a premixed bag of glucose–insulin–potassium for the metabolic management of diabetic patients in the perioperative period.
- The **Alberti regimen** has been superceded in many centres by the use of separate infusions of insulin (usually 1 U ml\(^{-1}\)) and glucose with or without potassium.
On Day of Surgery
1. Fasting blood sugar, Urine sugar, basal data
2. No breakfast and morning dose of insulin
3. Deserves to be taken as first case.
4. To avoid starvation, ketoacidosis IV drip 5% Dextrose with 1/3rd dose of total insulin daily requirement
5. Intra operative second 1/3rd dose of insulin
6. Omit remaining 1/3rd dose
7. Post operatively insulin if required by titration method.
Postoperative Management - Insulin

- Restart insulin at modified dose if required
- Supplement with SC sliding scale with meals
- For patient on IV insulin, continue until eating well and ensure overlap with SC insulin
- Never leave T1DM without insulin – risk for DKA
## Sliding Scale Regimen

<table>
<thead>
<tr>
<th>Glucose in mg/dl</th>
<th>Regular Insulin S/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-200</td>
<td>2 unit</td>
</tr>
<tr>
<td>201-250</td>
<td>4 unit</td>
</tr>
<tr>
<td>251-300</td>
<td>6 unit</td>
</tr>
<tr>
<td>301-350</td>
<td>8 unit</td>
</tr>
<tr>
<td>≥350</td>
<td>10 unit</td>
</tr>
</tbody>
</table>
VELLORE REGIMEN

- All patients had blood glucose measured at 6 am.

- For those patients whose operation started in the morning (7:30 am), no glucose or insulin was given in the ward.

- All other patients receive a glucose insulin infusion in the ward, if their blood glucose is more than 100 mg/dL.

- Regular insulin 5 U in 500 mL of 5% dextrose in water solution (D5W) was started in the ward at 8 am @ 100 mL/hr until the time of operation.
# VELLORE REGIMEN

<table>
<thead>
<tr>
<th>Blood sugar (mg/dL)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70</td>
<td>Stop insulin if on insulin. Rapid infusion of 100 mL of D5W, measure blood glucose after 15 min</td>
</tr>
<tr>
<td>71-100</td>
<td>Stop insulin, infuse D5W at 100mL/h</td>
</tr>
<tr>
<td>101-150</td>
<td>1U of insulin + 100 mL of D5W/h</td>
</tr>
<tr>
<td>151-200</td>
<td>2U of insulin + 100 mL of D5W/h</td>
</tr>
<tr>
<td>201-250</td>
<td>3U of insulin + 100 mL of D5W/h</td>
</tr>
<tr>
<td>251-300</td>
<td>4U of insulin + 100 mL of D5W/h</td>
</tr>
<tr>
<td>&gt;300</td>
<td>1U of insulin for every 1-50 mg more than 100 mg/dL + 100 ml of normal saline/h</td>
</tr>
</tbody>
</table>
Postoperative Management - OHG

- **Metformin**
  - Contraindicated in severe renal impairment
  - Avoid in conjunction with IV contrast

- **Sulfonylureas**
  - Can induce sig and prolonged hypoglycemia
  - Avoid or modify in erratic or poor PO intake
  - Deterioration in renal function can increase risk of hypoglycemia

- **Thiazolidinediones**
  - Associated with fluid retention
  - Avoid in advanced CHF
Emergency Surgery in Diabetics

- May be in diabetic ketoacidosis
- May be in diabetic abdomen.
  - Ultrasound to confirm
  - CT Scan Abd. Pathology.
- Control of D.M. by titration method
- Minimal surgery
- Optimal anesthesia management
- Optimal post-operative care.
When to suspect:

1. Early: Failure to come out of anesthesia
   - Diabetic ketoacidosis
   - Unexplained hypotension

2. Late: Septicemia
   - Increased infection
   - Non healing of wound.
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Surgery for relief of Diabetes Mellitus

- Secondary Diabetes: Treat the cause
  - Adrenalectomy
  - Hypophysectomy

- Chronic pancreatitis: Drainage procedure

- Primary Diabetes:
  - Islet cell of Langerhan transplant
  - Foetal pancreatic transplant
  - Total pancreatic transplant
  - Neoprene treated pancreatic transplant.
Metabolic surgery

- Gastric bypass better than sleeve gastrectomy