

Anesthesia for liver transplantation



History

- 1963 First liver transplant (orthotopic liver transplantation)
- 1967 First long survival

Sir Thomas Starzl



- 1979 Cyclosporine-Sir Roy Calne
- 1987 UWI solution for improved organ preservation
- 1989 FK 506
- 1999 Living donor liver transplantation

History



T20.1 Caucasian Eagle & Prometheus



Introduction

- The treatment of end stage liver disease underwent dramatic transformation with the development of LT
- LT is one of the most successful organ transplant after kidney transplant in terms of survival



Improved survival

- Improvement in preservation techniques
- Advances in Intraoperative management
- Refinement of surgical techniques
- Better immunosuppressive management



Background

- genetic relationship
- the anatomical site of the implantation
- auto graft
- isograft or syngeneic graft
- allograft or homograft
- xenograft or heterograft



Background

- Orthotopic transplantation
- Heterotopic transplantation



Blood type compatibility chart

Blood Type	Can receive liver from:	Generally can donate a liver to
O	O	O, A, B, AB
A	A, O	A, AB
B	B, O	B, AB
AB	O, A, B, AB	AB



Liver transplantation activity in India

- Estimated 200,000 patients suffer from liver disease
- No viable long term bridging options exists
- Approximately 60 liver transplants per year
- First attempt at cadaveric LTx in 1994 at AIIMS
- Organ procurement -ORBO and MOHAN organizations



Transplant team

- Anesthetist
- Hepatologist
- Transplant surgeons
- Transplant coordinator
- Clinical dietician
- Physiotherapists
- Social worker



CVS changes

- "Hyper dynamic circulation"
- Elevated cardiac output
- Decreased peripheral resistance
- Hypotension
- Vascular hypo reactivity
- Splanchnic and systemic arteriolar vasodilatation
- Cardiac dysfunction
- "cirrhotic cardiomyopathy"



Respiratory changes

- Gas exchange alterations
- Hepatopulmonary syndrome
- Porto pulmonary hypertension
- Restrictive lung changes
- Blood gas alteration



Coagulation Abnormalities

- Liver plays a central role in haemostasis
- Coagulopathy parallels the degree of liver failure
- Reduced hepatic synthesis of coagulation factors
- Malabsorption of vitamin K
- Inadequate hepatic clearance of procoagulant factors
- Platelet:
 - impaired aggregation
 - increased adhesiveness



Renal system

- HRS
 - renal failure in the absence of intrinsic renal disease
- Intrarenal vasoconstriction
- Renal dysfunction is potentially reversible
- Renal function is regained in 40% to 95%



Child - Pugh Classification of Cirrhosis

Factor & Score	1	2	3
S. Bili mg/dl	<2.0	2.0 - 3.0	> 3.0
S. Alb g/dl	>3.5	3.0 - 3.5	< 3.0
Ascitis	None	controlled	Poorly controlled
PT prolongation INR	0 - 4 (< 1.7)	4 - 6 (1.7 - 2.3)	> 6 (> 2.3)
Encephalopathy	none	grade 1	grade 2-3



Physiologic consequences of cirrhosis

- Increased C.O
- Arterial hypotension
- Decreased SVR
- Increased total plasma volume
- Increased activity of vasoconstrictor systems
- Increased renal vascular resistance, decreased renal perfusion pressure
- Dilutional hyponatremia



Pharmacokinetics & Pharmacodynamics

- Due to changes in
 - Protein synthesis
 - Volume of distribution
 - Protein binding
 - Hepatic blood flow
 - Hepatic drug metabolism
- Resulting in
 - Altered Serum levels
 - Elimination half life
 - altered hepatic extraction ratio
 - increased free drug levels



Preoperative assessment

- Performed jointly by hepatologist, surgeon and anesthetist before listing



Indications for Liver Transplantation in Adults

- Presence of irreversible liver disease and a life expectancy of less than 12 months with no effective medical or surgical alternatives to transplantation
- Chronic liver disease that has progressed to the point of significant interference with the patient's ability to work or with his/her quality of life
- Progression of liver disease that will predictably result in mortality exceeding that of transplantation (85% one-year patient survival and 70% five-year survival)



Indications for Liver Transplantation in Adults

- Chronic Hepatitis C
- Chronic Hepatitis B
- Cryptogenic cirrhosis
- Hepatocellular carcinoma
- Alcoholic Liver Disease
- Fulminant Hepatic Failure
- Wilson's disease
- Primary Biliary Cirrhosis
- Metabolic and genetic disorders



Contraindications

- Extra hepatic cancer
- Active sepsis
- Advanced cardiac disease
- Advanced pulmonary disease
- HIV with AIDS and low CD4 count



Goals of evaluation

- Which patients require LT?
- Which patients would benefit?
- When such therapy should be undertaken?



Goals of evaluation

- Understanding the underlying liver disease
- Development of complications
- Remote organ dysfunction (cardiac, pulmonary and renal)
- Optimization of nutritional and medical therapy



Preoperative assessment

- **AIM** :identify physiological abnormalities
 - :attempt to improve and optimize
 - :preoperative assessment is tailored to accommodate the clinical needs of the patient



Liver Transplantation-evaluation

- Medical history-
 - Symptoms such as fatigue, itching, swelling, changes in mental status and GI bleeding
 - Other medical problems
 - Medications
 - Includes alcohol use and drug use history
- Physical examination
- Blood tests
- Determine current functional status of the liver



Liver Transplantation-evaluation

- Concomitant medical problems
 - Heart
 - Lung
 - Kidney
 - Bone thinning



Liver Transplantation-evaluation

- Determine cause of liver disease
- Document severity of liver disease
- Determine survival and functional ability
- Concomitant medical problems
- Psychiatric evaluation
- Social Evaluation



Assessment of the patient

- Does the patient need transplant at this time
- Will the patient survive the procedure
- Will the patient meet the 50% 5yr survival criterion
- Does the patient understand the implications of transplantation



Cardio respiratory assessment

- CAD - resting 2D echo and DSE
 - best strategy unclear
- Respiratory - room air ABG
 - PFT's
 - HPS - indication for Tx
 - PPS - defer Tx



Liver donation

- Conventional adult deceased donor procurement
- Nonheart beating donors and
- Insitu splitting the deceased donor liver
- Living related organ donors



How Much Liver Do You Need?

- Liver = 2% body weight
- Optimal: > 1% liver weight/body weight ratio
- Liver remnant volume -30-40% of total liver volume
- Minimum graft volume -40% of standard liver mass



Theatre preparation

- Consultant and assistant anesthetists
- Perfusionist
- Lines and physiological monitoring
- Infection control
- Immunosuppression
- Blood loss and replacement
- Biochemical monitoring

OT Preparation Checklist

- OT Preparation Checklist
 - Warm OT to 21 - 26°C
 - Fluid warmers (e.g. Hotline)
 - Airway heater / humidifier
 - Convective warming device
 - Fluid pressurizing device
 - Cell saver
 - Stat lab availability
 - Packed cells
 - FFP
 - RDP or SDP
 - Drugs - Anaesthetic and general
 - Monitoring devices





Vascular access

- Large bore IV cannulae
- 8.5F catheters placed in the antecubital fossa
- 8.5F (two) placed in right IJV
- Rapid infusion system
- Veno-venous bypass catheters
- Arterial access



Monitoring

- Complete invasive monitoring is mandatory
- CVS - ECG, direct arterial pressure, CVP and CO
- RS - EtCO₂, ABG, pulmonary artery pressure
- Coagulation - platelet count, INR, fibrinogen and TEG
- Liver - ammonia, lactate, bicarbonate, potassium, glucose and temperature
- CNS - ICP
- Renal - urine output



Induction of anesthesia

- ECG and arterial pressure monitoring are commenced
- Invasive cardiovascular monitoring pre/post induction
- ALF patients - shift with ICP bolt monitoring
- Induction drugs tailored to maintain CVS stability
- Rapid sequence induction technique :
 - reflux and ascitis
 - short notice



Maintenance of anaesthesia

- Analgesia and muscle relaxants –
 - Remifentanil/fentanyl
 - Atracurium/Vecuronium
- Supportive drugs – dextrose infusion, calcium
 - sodium bicarbonate
 - antifibrinolytics (aprotinin, tranexamic acid)
 - N-acetylcysteine (mucomix)
- Vasopressor/inotropes – noradrenalin (adrenor)
 - dopamine



Intraoperative management

- Severe coagulopathy
- Metabolic disturbances
- Massive fluid shifts
- Blood loss
- Temperature derangement
- Hemodynamic instability and
- Renal dysfunction



Intraoperative management - principles

- Surgery falls into three phases -
 - Phase I-dissection phase (skeletonization of the native liver)
 - Phase II-an hepatic phase (removal of the liver)
 - Phase III- reperfusion phase (graft reperfusion, haemostasis and completion of arterial anastomosis and Biliary drainage)



Intraoperative Crisis

- Cardiac rhythm disturbances
- Hyperkalaemia
- Reperfusion syndrome
- Pulmonary hypertension

Donor hepatectomy

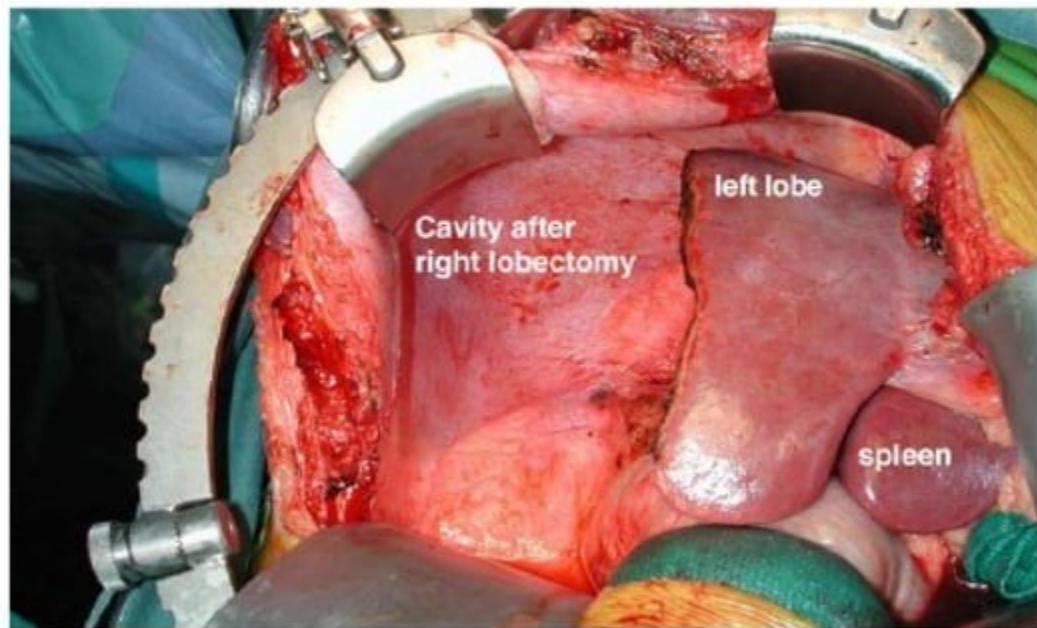
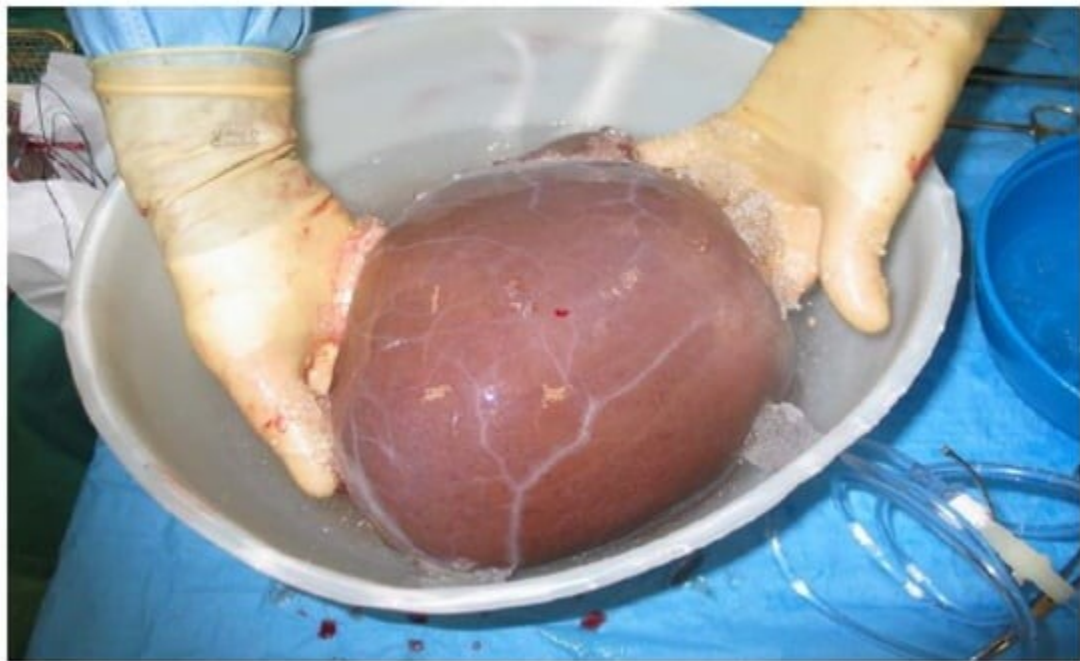


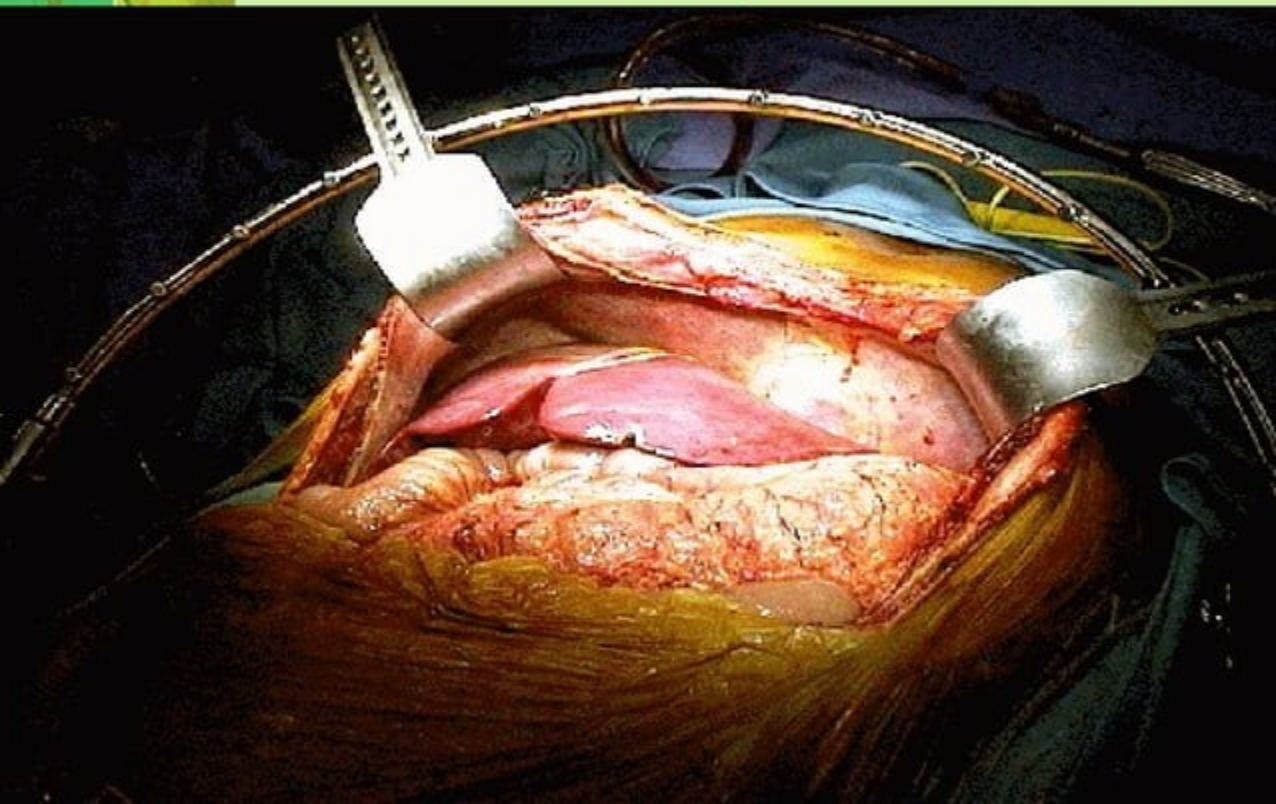
Fig. 1. Right upper quadrant after right hepatectomy.

Harvested liver





New liver grafted





Ischemic-reperfusion injury

- Decrease in $>30\%$ of MAP occurring within 5mins of graft reperfusion and lasting 1minute
- Hemodynamic changes include:
 - reduction in MAP
 - reduction in SVR and
 - reduction in myocardial contractility



Postoperative management

- Haemodynamic support
- Ventilatory support
- Metabolic support
- Haemostasis support
- Renal support
- Prevention of infections
- Early nutritional therapy



Postoperative care

- Ventilatory support for 6-12hrs
- Sedation and analgesia (propofol and fentanyl)
- Tight glycemic control
- Coagulation and full blood count tests
- Hct between 24-30
- Immunosuppression at the earliest
- Frequent doppler assessment of the graft



Post-operative complications

- Primary nonfunction (5%)
- Right pleural effusion
- Hemorrhage
- Renal failure
- Electrolyte Derangements
- Thrombocytopenia
- Biliary leak
- Hepatic artery thrombosis



Induction of Immunosuppression

- Triple therapy
 - Calcineurin inhibitor (tacrolimus, cyclosporine), anti-proliferative agent (mycophenolate), corticosteroid
 - Initiated immediately following transplantation.



Liver Transplantation-Outcomes

- 1-year survival ~90-94%
- 5-year survival ~75-80%



Anesthesia for non-transplant surgery

- Preserve hepatic blood flow
- Avoid hepatotoxic medications
- Correction of coagulation abnormalities
- Monitor postoperative liver function
- High suspicion of infection at an early stage
- Providers at high risk for hepatitis



- The entire goal of organ transplantation is to save another human life

Success

Team Work

