RESIDENT HANDBOOK

PAEDIATRIC ORTHOPAEDICS 2005
ROYAL CHILDREN'S HOSPITAL
MELBOURNE

AUTHOR

Naseem Mirbagheri

EDITORS

Michael Johnson
Greta Palmer

INTRODUCTION

The aim of this handbook is to introduce both resident and registrar to field of paediatric orthopaedics in the setting of postoperative care, in particular those who are not familiar with paediatric care. This is especially designed to cater to every consultant's recommendations in optimal care of their postoperative patients. This in no way is a protocol or guideline for care of such patients but only based on experience of senior consultants, evidence base medicine and my own experience at a junior level. By compiling this handbook I hope to expedite the familiarity of resident to ward care and expectations of each consultant.

I wish you all a very enjoyable and satisfying term at RCH Orthopaedics which is not only the centre of expertise in paediatric orthopaedics but also an internationally known centre for Cerebral Palsy research.

Naseem
Resident, Term 1 2005

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THE TEAM

Director
Mr Leo Donnan – general and limb construction, Theatre all day on fridays

Consultants
Professor Kerr Graham – general and Cerebral Palsy
Mr Gary Nattress-general and scoliosis
Mr Mark OSullivan –Tumours and general
Mr Michael Johnson-Scoliosis surgery and general
Mr Ian Torode- Director of clinical Orthopaedics, general and Scoliosis
Mr Paulo Selber-general and cerebral palsy
Dr Sue Liew – Scoliosis

Nurses
Unit Manager-Kirsten Davidson
In charge- Leanne
Jo
Fionna
Barbara
Scoliosis Nurse- Kylie Moon

Fellows
1 or 2 fellows at any one time, the fellows are attached to one consultant rotate annually
Consultant to resident, who acts as the ward 'registrar'

Registrars
Accredited 3 rotating every term each assigned to two consultants for 1 month and then rotate
Can have one or two unaccredited

Resident
-one rotating every term

RESIDENT'S ROLE

COMMUNICATION NETWORK

I think the most important thing one needs to realize is that orthopaedics is a big unit with many consultants and registrars and we receive every day. Patient number varies from 10-30 or more and a resident's foremost role is to coordinate the postoperative care of these patient by liaising with each registrar and if necessary respective consultant. Communication is crucial and not only is it the responsibility of every registrar and fellow to update you with every plan or any changes to the plan but it is absolutely crucial for you to feedback to the respective registrar or fellow of any complications postoperative (significant ones not things like nausea and pain!) to ensure that this link is continuous and accurate. This communication network should extend to nurses, physiotherapy, CDR and pain team.
You will find that 4N is probably the most organized and efficient wards in the hospital and I wonder why they haven't been awarded the best ward of the year! You normally discover this on your first day on call when you have to cover other surgical wards!

MORNING WARDROUNDS
-Usually at 745 am , be on the wards at 730am check results from day before especially Hb and UEs and CRPs (esp in septic arthritis/osteomyelitis), remember we don't do blood test just like that for kids there always has to be a good reason for it. Not all kids need preop and postop bloods. Pick up from the printer a ward handover sheet which is fantastic and it reminds you what the plan for each kids are or who actually they are! .
You should have a consultant at the ward round on Monday, Wednesday and Fridays. The other days either the registrar or the fellow leads the ward round. On Wednesdays orthotics attend too, other days only physiotherapist and nurse in charge. This ward round is central to the day and it sets out your work for the day usually.
-MAKE SURE you write in the GREEN TREATMENT SHEET every morning for each patient, sometimes it is hard as you have to listen, fill out xray cards and check vital signs all in 1 minute of that patient's visit. But it is crucial as you invariably tend to forget what the plan for each kid was.

CDR WARDROUNDS (see later pages for details)
=on Tuesdays and thrusdays.
thursdays .

THEATRE

Unfortunately I did not get to go to theatre as much as I would have liked to, being the only resident it is hard to be at two places at the same time. But if you are lucky and efficient you can finish your ward duties by 10 am, ask ANUM to kindly write non-urgent tasks on the board and when you come up in between cases you can do them all at once, unless urgent.

RADIOLOGY

-requesting an MRI is probably the hardest and painstaking imaging to organise it is very rare unless urgent that they will accept an MRI on a short notice, remember book early if you expect it.

-CT is not as bad, talk to reg of the day for CT if you want it same day otherwise give the slip to the reception girls, always write on the slip the ward name, consultant name, if the child is in hip spica (as these kids cant move so CT can be undertaken easily without sedation or GA , this applies only for CT of hip)

-Bone scan-much easier to book just give it to anyone you find at nuclear medicine and they usually give you a time same day or next day!

-Plain xray , all you do is sign the slip and give it to ANUM and she will organize it for you- how nice!

WEDNESDAY MORNING CLINICAL CONFERENCE

Good fun, always new things to learn usually go over the previous week's operations, admissions and next weeks planned surgery. Teaching for registrar including real patient examination. It is nice to see everyone together one day in a week it keeps reminding you that we all are a team aiming to straighten kids ie orthopaedics!

Finishes at 1030 unless business meeting whereby you finish at 930 after which there is a ward round, it starts at 8am, but you should come earlier and organizes the fluids for the kids and solve any issues before the meeting otherwise the ward is not going to cope without you until 1030am!

HOURS

Technicaly 730 to 430 pm but I guarantee you that you will never get out by 430 pm, there has been days (though infrequent) that I have been there untill 7 pm; at least unlike St Vincent you are paid overtime. Afternoon off, lucky if you have one, no fix days, I usually took them on good days always confirm with ANUM and your fellow and get the evening person or a good friend to cover.

DISCHARGE PLANNING

It is always a good idea to plan every patient's discharge on day 1 and discuss it on the ward round, things move much faster if a date for discharge is set for every patient. Our responsibility is to make sure that any drugs especially analgesia is prescribed for home, F/U xray form is filled , outpatient appointment is organized. There are two types of outpatient forms : one for CP and complex procedures whereas the other simple format. The importance of the former is that it needs to be filled out completely (by registrar or yourself), state correctly the procedures performed, and what things need to be done on day of appointment for eg xray, see orthotics etc (don't forget to explained to the parents exactly what the slip says). Parents usually take the slips to the third floor to make the appointment.

With respect to the discharge summary, honestly at RCH they are dead easy (compared to most other hospitals) and it shouldn't take more than couple of minutes each. Officially they are the responsibilities of registrars to do them however sometimes it is better for you to do them as the patient has been in ward for long and complications eg constipation needs to be typed in or handwritten if already printed (as they earn the hospital more money!). So on day of discharge of the patients check if it is started and if so finish it with appropriate updates otherwise you can either choose to leave it for the reg or if is simple straight forward just do it , seriously it takes few minutes.

CHILD DEVELOPMENT AND REHABILITATION -CDR

Been around only since 2002, Great medical resources, you will soon find out that your registrar have limited paediatric knowledge (as they are mostly adult trained) and to have a support system in place at all times is really appreciated (especially when most residents are adult trained too!). CDR is involved mainly with care of children with disability and they are really good with issues such as epilepsy in CP (esp when oral antiepileptics are not tolerated perioperatively) and any other medical issues that you have with a patient. It is really your call; the extent of their involvement depends entirely upon you.

Their team involves a registrar, resident and few consultants. Have at least one round with reg and even if you have no issues introduce the potentially complicated patients to them eg CP kids post VDROs or SEMLS.

PAIN MX

Pain management in children is crucial mostly because they can't communicate their pain to us as effectively as adults especially infants and if developmentally delayed. We, fortunately, have a great pain service team with experienced nurses whose role is to review all children under their care ie those with epidurals insitu and postoperative opioid infusions and PCAs. If you have certain kids that you are worried about painwise, it is very easy to call for phone advice or refer them to pain team. There is usually a consultant and/or anaesthetist registrar who does a ward round every morning and reviews the patients with the pain service nurses.
Even though the pain service does most of your work for you including recommending analgesia and weaning dose, it is important for you to have some basic pain management skill.

Paracetamol
All children should be on it, 15 /kg 4-6hrly, if background analgesia is required STRICT 4-6hrly should be prescribed. If you write 4-6hrly then the maximum safe dose should by also prescribed in the comment box (max 90mg/kg short term use or 60mg/kg 3-5days use), if you forget usually and luckily the pharmacist does it for you!

Codeine
Again a very common analgesic, 0.5-1mg /kg 4-6hrly/PRN, make sure you put in a range otherwise the nurses will be very cross with you. Always prescribe laxatives with codeine as constipation is very common .10% of Caucasians can't metabolize codeine thus receive no analgesic benefit so alternative regimen is necessary in such patients.

Morphine

The only way you can prescribe morphine is as morphine 50 or 500ml infusion or via intermittent morphine boluses, on a special pink chart that you can attach to the drug chart, which is specifically for this purpose. For intermittent boluses the dose is usually 0.2mg/kg diluted to 10ml of Normal saline, with 2ml boluses. Major side effects include constipation and risk of respiratory depression. Opioids depress ventilatory drive by reducing sensitivity of the respiratory centre to hypercarbia and hypoxia. The first sign is sedation then respiratory rate and then ~~reduce in~~ tidal volume, Oxygen desaturation is actually a LATE sign.

Oxycodone/Oxycontin

Frequently used post weaning off PCA in scoliosis patient and they are sent home with it and weaned by the pain service nurses or GPs.

NSAIDs

Ibuprofen- great drug for pain mx post bone/muscle injury or surgery, there is controversy regarding its use and the respective consultant's preference should be taken into account. NSAIDS have been shown (mainly **animal** studies) to diminish bone formation, healing and remodeling. Thus If you decide to use it, short term may be the wiser choice.

Tramadol

1-2mg/kg IV/PO 6-8hrly/PRN, its license is limited for use in paediatric population in Australia thus it can only prescribed by anesthetists at RCH. A centrally acting analgesic of moderate potency with dual mechanism of action including weak agonist effects at the mu-opioid as well as inhibition of serotonin/noradrenaline reuptake. Its appeal is that it can be given via IV or oral and its relative lack of sedative action and respiratory depression. This advantage is particularly useful in kids who are at risk aspiration pneumonia secondary to loss of respiratory reflexes. However its use is potentially limited by nausea, vomiting and seizure exacerbation.

Diazepam

Anxiolytic, sedative hypnotic agent with muscle relaxant property but no analgesic property. 0.05-0.1mg/kg 4-6hrly/prn, used mainly for spasms in cerebral palsy. Care must be taken not to oversedate the kids and not to be used inappropriately eg post simple fracture kids!

Clonidine

Alpha-adrenoceptive agonist, you will see it given commonly via IV or epidural route intraoperatively eg CP kids post VDROs or other major bony procedure. When given intrathecally or via epidural, it acts on dorsal horn

of spinal cord both pre and postsynaptically. It directly suppresses spinal cord nonciceptive neurons and potentiates effect of local anesthetics. There is good evidence that addition of clonidine (1-2ug/kg) to local anesthetic prolongs the duration of caudal analgesia without untoward side effects. Its side effects include bradycardia, hypotension and sedation. Respiratory depression is not supported in recent studies of 4ug/kg, except in overdosed. If hypotension or bradycardia occurs postoperatively consider contacting Pain services or MET call as necessary.

PROCEDURAL PAIN AND SEDATION

Local anesthetic eg Angel or EMLA and distraction often suffice. In other kids the case may be entirely different especially with previous bad experiences. Try distraction but if the patient is already worked up especially when they have learned to associate application of EMLA to needles, sedation may be your only hope!

Topical anesthetic
EMLA (lidocaine and prilocaine) or **Amgel** (amethocaine gel). A thick layer is applied to skin and covered with an occlusive dressing. The depth of analgesia penetration depends on duration of contact with skin; 4-5 mm is achieved 45-60min after application. Analgesia is maintained for up to 30-60 min following removal of cream. Complications are rare, most serious mehemoglobinemia (induced by prilocain, inadvertent ingestion may result in airway anesthesia and loss of airway protective reflexes.

Midazolam
Anxiolytic, sedative –hypnotic, **amnesic**, muscle relaxant agent. No analgesic property thus don't forget EMLA/Amgel. Oral, IV, intranasal and sublingual are all possible routes of administration. Oral dose 0.5mg/kg produces anxiolysis in 15-20 minutes with mean duration of action of 40min. Midazolam orally is very bitter because it contains the preservative benzyl alcohol, masking the taste with flavoured mixture is one option.
When administered intranasally the dose should be 0.2-0.4 mg/kg as midazolam is absorbed rapidly across mucosal surfaces and sedation occurs within 5-10minutes. Intranasal is usually disliked by kids as the benzyl alcohol may burn the nasal mucosa thus it will sting. When used as a sole agent, cardiorespiratory compromise is not common as at usual doses patient remains awake, this makes it more useful for older kids who require merely anxiolysis. At lower doses it can cause paradoxical excitement especially if pain is present.

Chloral Hydrate

An alcohol based sedative hypnotic agent with no analgesic properties. Because of its ease of administration(liquid) and safety it remains one of the most popular sedative agents used in the pediatrics population mainly because of its favorable cardio-respiratory profile –at RCH you see it used often for radiological or echocardiographical procedures. Dose 30-50mg/kg max 2g oral or rectally. Time to onset 25minutes, duration of 60-90min but may last more than 6hrs.
However it is unpalatable taste and has the potential to cause GI upset/vomiting, ataxia and paradoxical agitation (especially in older kids with neurological disorders).

Ketamine
A dissociative anesthetic chemically related to phencyclidine, providing sedation, ANALGESIA and amnesia. Advantages include a relatively short duration of action 15-30min , multiple route of administration (nasal, oral , IV), provision of both analgesia and amnesia as well as cardiorespiratory profile. It is popular for painful or invasive procedures including fracture reductions, invasive line insertion, oncological procedures.
Given that it can cause laryngospasm patient should be fasted. 0.5-1mg/kg IV, orally 7-10mg/kg, adverse effects include GIT disturbances, emergence hallucination (esp older kids)/delirium.

Guidelines for discharge prescription of opioids (other than codeine)

Stephanie Dowden, Children's Pain Management Service
Greta Palmer, Children's Pain Management Service
Thirza Titchen, RCH Pharmacy

Royal Children's Hospital
March 2005

Always check with the Children's Pain Management Service (CPMS) to clarify the patients' discharge analgesia requirements. The CPMS provides phone follow-up to all their patients on oral opioids (excluding codeine) and supervises opioid-weaning regimes.

A small number of children are discharged from the Royal Children's Hospital on strong oral opioids following major surgery such as spinal surgery or reconstructive thoracic surgery or for complex medical and/or surgical conditions. Most often, children are discharged on a combination of oxycodone (*Endone*) and oxycodone controlled release (CR) (*OxyContin*) **OR** morphine (tablets or elixer) and morphine controlled release formulations (*MS Contin*).

The PBS quantity for most oral opioid prescriptions is **20 tablets** with nil repeats (December 2004). This applies to higher strength codeine preparations (eg *Panadeine Forte*), oxycodone (*Endone*), oxycodone CR (*OxyContin*), morphine and morphine controlled release (*MS Contin*).

A HIC authority number **(HIC** ph: **1800 888 333)** is required for larger than PBS quantities to be dispensed or for repeat prescriptions. ~~More than one item may be prescribed on a hospital PBS prescription.~~ Phone approvals for authorisation for Drugs of Addiction prescriptions are limited to 4 weeks supply. Quantities for up to 3 month's supply may be obtained by posting an Authority Prescription Form to the HIC.

If requested by CPMS to order a combination of tablet sizes (to enable weaning) please specify this clearly on the prescription. The quantity of tablets/mixture to be supplied must be written in words **and** numerals. More than one item may be prescribed on the white A4 hospital PBS prescription.

e.g. For a patient on oxycodone CR (*OxyContin*) 30mg BD with oxycodone 5-10mg 4/24 prn rescues,
this patient needs 3 prescription items written:

Prescription should read::

Oxycodone CR (*OxyContin*) 10mg 20 (twenty) tablets
Oxycodone CR (*OxyContin*) 20mg 20 (twenty) tablets
Both these tablet sizes are required for weaning *(This statement is written to ensure pharmacy dispenses both tablet sizes)*

Take oxycodone CR (*OxyContin*) 30mg po BD

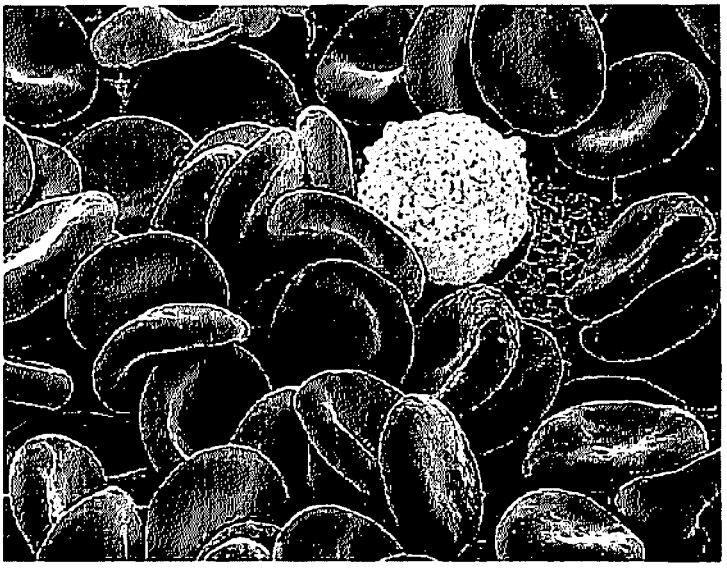
Products:

NB Some of these products are not regularly stocked at RCH and are not available on PBS.
If unsure check PBS listing in the Schedule of Pharmaceutical Benefits or at www1.health.gov.au/pbs/scripts **or ask CPMS or ward pharmacist or call pharmacy on ext 5492.**

Oxycodone (*Endone*) = 5mg tablets
Oxycodone oral liquid *(Oxynorm liquid)* = 5mg/5mL, 10mg/mL
Oxycodone controlled release *(OxyContin)* = 5mg, 10mg, 20mg, 40mg and 80mg tablets

Morphine = 30mg tablets
Morphine oral liquid = 1mg/mL, 5mg/mL, 10mg/mL
Morphine controlled release *(MS Contin)* = 5mg, 10mg, 15mg, 30mg, 60mg, 100mg tablets
Morphine controlled release oral liquid *(MS Contin Suspension)* = 20mg, 30mg, 60mg, 100mg sachets

BLOOD TRANSFUSION



You will find blood transfusion can be controversial: at the same Hb one consultant may opt not to transfuse whereas the other will. As there are no hard and fast rules as it depends very much on the individual child in question. RCH is in the process of developing guidelines similar to the adult ones and once it is out things would be clearer.

Remember Kids can tolerate very low Hb (show signs generally at Hb<60), we tend to transfuse postoperatively when Hb<75-80 guided by signs , symptoms, ongoing blood loss, patient/parent factors and of course the respective surgical consultant. You may be told if the patient is symptomatic then transfuse however in postop kids in bed anemic symptoms are usually hard to elicit (eg SOBOE) unless they are up and going and complaining of postural dizziness and fatigue. Signs of hypovolemia will generally mean give more fluids and sometimes blood. One also has to consider that the average kid in the ward has only 2-3 L of circulating blood volume (70mls/kg), thus only 1L of blood loss which could easily be under-estimated intraoperatively will mean loss of 50% of their blood volume!

Blood is not to be given lightly due to its potential infective risk eg HIV so really only give if the benefits outweigh the risk and of course if a consultant or fellow tell you to do so.
Remember too much blood can also be harmful for a kid it can increase the viscosity of their blood, a good general rule:

Volume of blood = 4 X weight X (change in HB desired)

This is from Frank Shann's book: 4ml/kg of blood will increase Hb by 1 unit/gram.

Each unit of blood has about 250-350 mls (specified on each bag) of blood and you tend to run it at their usual maintenance rate or similar to adults over 3-4hrs. Any Xmatch that you do is only valid for 72hrs. Remember if you transfuse amount equivalent to the patient's total blood volume you will need to consider FFP.

Blood collecting

You will need minimum of 1.5ml for grouping and 0.5ml for every unit you cross match. Any EDTA red cap tube or vial is appropriate. There is no special form for blood transfusion to fill, you can use the same slip for all tests you want and no need for anyone to witness it either! PLEASE make sure when you're doing cross matches for more than 1 patient (usually the case with preop admissions); you don't mix them together (trust me when you are busy it is possible). Do one patient's blood test at a time, label, sign and date it and then send it away or put it on the tray and then do the next!

Haemoglobin Dilution

Surgeons may attribute drop in Hb due to too much intraoperative IV fluids and use the low hematocrit to support this. Remember the intravascular volume is usually fixed in a kid unless they are hypervolemic secondary to renal or cardiac dysfunction or they are vasodilated secondary to drugs or infection etc . IV fluids eg dextrose redistribute themselves within 1 hr and colloids within 4-6 hrs and thus all will eventually take residence in extravascular space.

Hb concentration (gram/litre)= Hb(g)/intravascular volume(l)

The only way you can drop your Hb is to either loose blood or having the blood diluted by IV fluids **before the redistribution phase** especially when large amounts of fluids are given. Thus you can't dilute the Hb by just giving IV fluids unless the intravascular volume is increased. There is an argument that the vascular space increases by 10-15% postoperatively ?secondary to anesthesia or ?SIADH. However even if this is true, 15% increase will hardly be clinically significant ie you may expect a decrease in Hb by 1 unit maxiumum. There are two studies [9,10] that I have come across which state an increase in intravascular space post spinal fusion with SIADH, one clearly states an increase in CVP and the other claims that significant Hb dilution can occur postoperatively, in both studies the number of patients were less than 20 and thus one can't generalize this to all postop patients.

Reticulocyte count

Normal range 0.2-2%, Reticulocyte count reflects marrow erythropoietic activity and corresponds to the finding of polychromasia on a blood film. A low reticulocyte count in the presence of anaemia indicates bone

marrow failure or haematinic deficiency. You normally expect reticulocytosis posthemorrhage in a healthy bone marrow with adequate Fe. In postoperative patients with significant fall in Hb but not enough to require transfusion, consider giving couple of months of Fe supplements especially in those with low reticulocyte count.

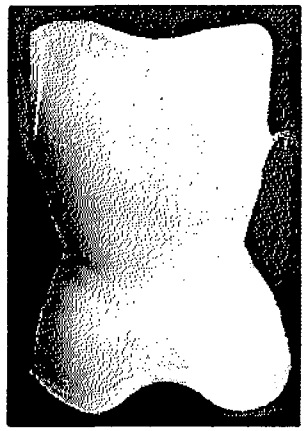
Adverse effects of transfusion *(adapted from RCH guidelines)*

- Febrile reactions: common, ensure that patients weren't febrile preoperatively , It is thought to be cause by recipient's antibodies reacting with white cell antigen or white cell fragments in the blood products or due to cytokines which accumulate in the stored blood. It also may be the initial symptom of bacterial contamination or hemolytic reactions. Mx: symptomatic, Paracetamol unless you suspect a more serious underlying cause.
- Urticarial reactions: 1% of recipients , caused by foreign plasma proteins, rarely laryngeal edema or bronchospasm. Mx: if in isolation, reduce rate or temporarily stop transfusion +/- antihistamine. Otherwise if febrile or other sx stop and send blood for inx.
- Anaphylactic reactions: hypotension, tachycardia, arrhythmia, dyspnea, stridor. Mx: stop, supportive care, adrenaline. Higher risk in those with anti-IgA antibodies, such patients need special blood products.
- Acute Hemolytic reactions: ABO incompatibility, mainly due to technical errors. Main symptoms chills, fever, pain in the chest, back, along IV line, hypotension, DIC, bleeding from IV site. Mx: stop, notify, ICU admission.
- Bacterial contamination; more common with platelet transfusion, very high fever, hypotension, nausea are typical signs. If suspect stop, blood cultures , antibiotics. Prevention: if the bag looks dodgy don't use it, ensure it is given by 4 hrs max.
- Transfusion related lung injury: TRALI is characterized by ARDS, hypoxemia within2-8 hrs of transfusion, secondary to antibody to recipients WBC, will need ICU admission.
- Volume Overload: usually uncommon in kids to give lasix though it may be warranted in some cases.
- Hypothermia: cold blood given rapidly
- Citrate Toxicity: Citrate is the anticoagulant used in blood products, manifested by hypocalcemia and hypomagnesemia with rapid administration of large volume of blood. Citrate usually is metabolized by the liver given time and functioning liver. Ca and Mg may be required temporarily.
- Hyperkalemia: when blood stored for long or irradiated way before it is given. Uncommon with controlled volume of blood transfusion.

ORTHOTIC DEPARTMENT

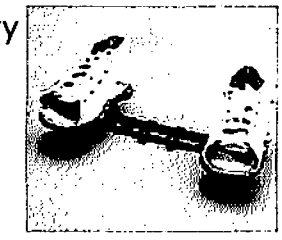
Edited by Nicole Galea

Located on the ground floor we probably have more to do with this department than any other. The name of the orthosis usually specifies the purpose it serves or the anatomical site it acts on eg hip abduction braces, ankle-foot orthosis



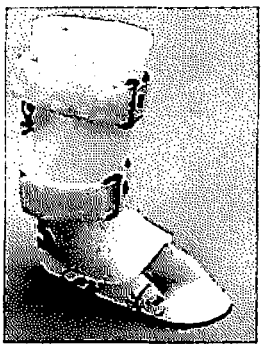
Common Brace types:

- **Thoraco-lumbo-sacralorthosis(Boston brace)**: custom molded from plastic, works by applying three-point pressure to the curvature to prevent its progression. For thoraco-lumbar curves and apex of curve blow T6/7. Worn 23/24 a day.
- **Cervico-Thoraco-Lumbo-Sacral-Orthosis** (known as a Milwaukee brace), similar to boston brace but also includes a neck ring held in place by vertical bars attached to the body of the brace. Another major non-operative use of the Milwaukee brace has been in thoracic Scheuermann's disease. It is universally agreed that thoracolumbar Scheuermann's disease can be well treated with a Milwaukee.
- **Thoraco-Lumbo-Sacral orthosis (High Taylors brace):** This orthosis is used primarily post-operatively following spinal fusions for scoliosis. It is worn during waking hours as a visual reminder to others and themselves of recent surgery.
- **Neofrakt brace** (see above insert picture): a german product, easy to wear, lightweight, molded directly to patient's body via garment with zippers on the side. Can be used postoperatively for short term spinal support where more support is required than a TLSO (High Taylors).
- **Zimmer-splints:** assists in maintaining knee extension and preventing knee joint stiffness following a variety of knee operations. (For short term use, 6-8 weeks)



- **Three point Orthosis:** Used to reduce unoperated flexion contractures, contra indicated for osteotomies.
- **Aspen /Philadelphia collars**: used for long term (approx 6 weeks) cervical spine immobilization, they are rigid but flexible enough to prevent pressure areas. The Aspen collar has pads which can be removed and washed and also comes in infant sizes. The Philadelphia collar can be removed and washed due to it's closed cell foam construction.

- **Dennis Brown boots and bar**: straight lace shoes on a brace used for maintaining external rotation of the CTEV foot following correction via serial plaster casting.
- **Dennis Brown Hip abduction braces**: used in DDH to provide hip flexion and abduction for optimal remodeling of acetabulum of children under 12 months.
- **Pavlik harness**: used in treatment of hip dysplasia in infants who have reducible hips and are not standing
- **AFOs**(ankle foot orthosis): a molded leg support to help maintain alignment and provide stability.



SPINE PATIENTS

Two age groups:

- infantile- <4yrs , male>female, spontaneous resolution likely
- Juvenile- onset <10, when preadolescent more likely to progress with higher incidence of pulmonary and cardiac complication.

A Typical curve : convexity to the right with apex at T6-T10

x-ray of scoliotic spine

Surgery types:

- Anterior release (2-2.5hrs), usually multilevel discectomies and anterior spinal ligament release via thoracotomy done for those scoliotic patients with associated muscle shortenings and contractures, NOT required in patients with muscle weaknesses eg duchennes or spinal muscular dystrophy. Anterior instrumentation follows this if necessary, if posterior than done in two weeks (second stage).

- Posterior spinal arthrodesis and instrumentation for correction and stabilization of idiopathic scoliosis have been used with success for over 45years. Used in those who can either stretch out readily on XR traction table or have weak muscles. The hardware used commonly in RCH include the 'final frontier Titanium rods'-very colorful ones, luque and Cotrel- Dubousset (CD) instrumentation, Moss Miami (with or without pedicle screws) and others depending on surgeon preferences and patient variability eg idiopathic versus Cerebral palsy aetiology .

Regardless of the instrumentation chosen the goal of surgical intervention in idiopathic scoliosis is correction of three-dimentional deformity, restoration of balance, fusion of minimum of segments for preservation of spinal mobility and prevention of curve progression.

The general indication for the surgery is a curve greater than 45-50 degrees (cobb angle) at skeletal mature or 40-45 in those with 1-2 yr of growth remaining. In children less than 10 or with Risser stage 0 or one (scale based on xray signs of growth plate at iliac crest) both anterior and posterior spinal fusion should be undertaken to prevent rotational progression known as crankshaft phenomena. In non-idiopathic causes eg Duchennes and cerebral palsy the indication is usually to prevent cardiorespiratory embarrassment and to improve mobility.

Anterior instrumentation is usually done for high lumbar curves.

PREOPERATIVE EVALUATION

Usually undertaken by the consultants in clinic and investigations coordinated by our spinal coordinator nurse –Kylie Moon in 'preadmission clinic'. It usually involves family history; cardiorespiratory status, menarchal status and examination include measuring curve both clinically and radiographically, limb length discrepancy, neurological examination.

XRAYS

3 feet spine erect (unless wheel chair bound) AP and lateral OUT OF BRACE is routine preop and postop films, used preoperatively to assess the severity of curve and for monitoring and overall balance and alignment of spine. Right and left lateral bending done to assess flexibility of spine. Traction xrays undertaken to assess correctability.

WORKUP

-Xray as above
-Photos, spine series
-Respiratory function test, as these patients tend to have lower vital capacity and forced vital capacity , in those with less than 40% ICU postop is essential
-ECG
-Echo especially in Duchennes with their associated risk of cardiomyopathy
-UE, FBE, Xmatch 2-4 units, Coagulation studies
Given the high risk of blood loss , autologous blood donation is offered to patients.

INTRAOPERATIVE CONSIDERATION

-include arterial line with regular blood gas monitoring, 2 large IV cannula, CVC for duchenne, urinary catheter, bair hugger, Hb check intraoperatively, Intraoperative TOE monitoring for all Duchennes.
-cell saver: for more than 25kg and more than 2.5hr operation
-Spinal cord monitoring, used in conjunction or alternative to wake up test (waking up patient immediately post closure to ensure lower limb movments). It involves stimulation of peripheral nerve in lower extremity and recording the response proximal to the surgical area. This modality mainly monitors the dorsal column pathways, acute alteration in amplitude or latency of waveform of the potential are indicative of impending or actual spinal cord injury. Somatosensory evoked potential

for dorsal column pathway and motor evoked potential used to monitor anterior motor pathway. Only for patient who are neurologically normal eg not in CP.

POSTOPERATIVE COMPLICATIONS

You will be surprised that no DVT prophylaxis is instituted for any immobile patient in paediatric ward due to the very low risk of DVT in paediatric population even though there has been one death reported in an adolescent post spinal fusion secondary to pulmonary embolus.

Ileus- very common almost expected, most patient are nil orally day 1 postop , ice only day 2 and sips and clear fluid day 3 , FWD by day 5. The speed at which above regimen is implemented depends on presence of bowel sound and absence of abdominal pain and distention, during my time here I have had at least two patients with well established ileus requiring NGT and bowel rest , these patients are frequently the ones with cerebral palsy due to already existing problems with chronic constipation. Ileus tends to last for 2-4 days.

SIADH-
Studies have quoted incidence from 60-100% postoperatively, it is thought to be secondary to invasion of dura and traction on neural pathways intraoperatively, other causes to consider is narcotics and anesthetic agents. The syndrome is characterized by hyponatremia with hypoosmolality and inappropriately concentrated urine in the presence of normovolemia or hypervolemia and normal renal and adrenal function.

The first clinical indication that the patient may be developing SIADH is a decrease in urine output; the challenge is to distinguish this from oliguria secondary to hypovolemia to which the treatment is opposite to that for SIADH ie fluid resuscitation vs restriction, inappropriate treatment in either cases can be detrimental. Helpful clues include assessment of intravascular volume, plasma Na and osmolality and urinary Na/osmolaltiy. Remember that SIADH in this context is self limited to 1-5days postoperative state , the rise in ADH reaches its peak at 6-12hrs.

Brazel et al in their study showed that the use of normal saline in perioperative period can result in reduce rate of SIADH, at RCH we use 1/2NS with 5%dextrose, it is possible to use Normal saline with 5%dextrose, if I had the time such a clinical trial on 50-60 of our patients would have been a worthwhile reseach.

Problems with SIADH : Volume retention and hyponatremia and its inherent complications of pulmonary edema, cerebral edema, convulsions , coma , one study suggested that dilutional effect of SIADH can cause drop in Hb (see under blood transfusion for critics of this article). Make sure if they are hyponatremic you do not rapidly correct their Na (ie more than 12mmol/l/day) as the risk of osmotic demyelination syndrome with consequent brain damage can be a major risk.

Pooling due to positioning during surgery eg eye , face and lip edema not uncommon

Blood loss- Hb check day 1 postop and if low day 2 or 3. Blood loss through the drain tube, first find out what type of drain –is it intercostals or wound drain. Usually let it drain freely with or without suction, some clamp it to tamponade, ask the respective consultant. Do not make decisions on your own unless you were at the surgery for the whole time (if your are lucky)and know what to expect. If continuous blood loss with low Hb may need transfusion.

Infection- 1%, prophylaxis for 48hrs with antibiotics is common, UTI and especially fungal infection/Thrush in teenage girls secondary to the catheter and local maceration. The girls might not discuss with the male resident the itchy groin so ensure that the nurses take good local skin care of the area and inform you of any 'red blistery rash'.

Neurological injury- rare, usually detected intraoperatively and instruments removed or adusted.

Pneumothorax-with the sublaminar wires, rare

Ocular complications- abducens nerve palsy if in traction postop (for further straightening),? Retinal artery thrombosis secondary to prone position may present with double vision

CAST/Wilkie's /SMA superior mesenteric artery syndrome: 3rd part duodenum gets obstructed from tight stretched SMA when curve straightened → vomiting post op not resolving. Exclude with barium follow through. Usually treated conservatively with NG decompression, positioning and enteral feeding, in refractory cases surgery may be necessary.

POSTOPERATIVE MX

- **FLUIDS** : important, ¾ Maintenance to reduce the effect of volume retention with SIADH check UE day 1. Our aim is to keep the lung dry to

promote respiratory function while at the same time ensuring adequate renal function. Reduce fluids as oral intake increases, expect a good diuresis by day 2-3 when the third space volume is redistributed intravascularly. Once maintenance ceased continue Normal saline 500mls for drug line if on antibiotics (for any patient) at rate of 5mls/hr if less than 40 kgs or 10mls/hr if more than 40.

- pressure sores
- physiotherapy for chest if necessary , when to tilt, sit up and sit out of bed as per consultant recommendation
- Brace- high taylor brace adjusted by orthotics, request early on on the yellow card, not for all patients
- Laxatives
- Pain- usually on PCA, home on weaning dose of oxycontin and oxycodone.
- Encourage sitting up day 1-2, walking by day 3 (variable, also dependent on individual consultant's recommendations). Dr Liew encourages ambulation day 1!
- Discharge- once sitting out of bed, walking, bowels open, afebrile and otherwise well
- Will be seen in scoliosis clinic in 6 weeks with a repeat 3 feet spine xray AP and lateral out of brace.

CEREBRAL PALSY

A disorder of movement and posture which is permanent and non-hanging secondary to a perinatal neurological insult. The orthopedic ward is concentrated which such patients, main issues to consider in such patients:
- epilepsy
-spasticity
-constipation
-aspiration and respiratory distress – poor airway reflexes
-nutrition
-Central Hormonal dysregulation

The functional status is measured by Gross motor function classification measure (GMFCS) which rates from 1 (walking with a box) to 5 (totally dependent) .The rates of hip displacement correlates with the scale with 0% in 1 to 90% in scale 5.

Spacticity mx

Strategies depending on severity and site of spacitiy, mx options include any one or combination of the following:
- General – baclofen
- Reversible – oral eg diazepam usually postop eg post VDRO
- Focal- Botox, Phenolisation
- Permanent- Selective dorsal Rhizotomy

BOTULINUM TOXIN
It is injected into specific muscles to reduce muscle tone and spasticity. It blocks conduction at the neuromuscular junction by binding irreversibly at the motor endplates. It usually wears off in 3-6mths because of sprouting of new axons from the spinal cord.

HIP DISORDERS
Very common, important to realise that it is different from DDH, in CP the hip is normal at birth but with growth muscle imbalance and spasticity can drive the femoral head out of an otherwise normal acetabulum. The natural history is that of progression , such patients are then left with worsening hygiene, gait and pain.
Management depends on age and severity, but is usually a combination of soft tissue releases and bony procedures eg in SEMLS- single event multilevel surgery you may see bilateral VDROS (varus derotation osteotomies), tendon releases etc.

PERTHES AND SUFES(Slipped upper femoral epiphysis)

SUFE

Most common adolescent hip affliction in which dehiscence occurs at the femoral growth plate with posteroinferior displacement. Usually idiopathic, Risk factors: overweight, family history, male gender, endocrine disorders, connective tissue disorders, renal osteodystrophy.

Classification:

- acute: less than 3 weeks of symptoms
- acute on chronic: an acute exacerbation on background of symptoms
- chronic- symptoms >3 weeks

present with hip or knee pain with external rotation of the hip, restriction of flexion, abduction and internal rotation, unable to weightbear and may given you a hx of trauma. AP and frog leg lateral xray of the hip are usually diagnostic. Xray signs; apparent height of affected epiphysis is reduced so is the joint space and migration of neck of femur superior to epiphysis (klein line).

Mx: to prevent further displacement before physeal closure, keep child non weigthbearing and admit for In situ pinning ie no manipulation of the hip is undertaken to reduce it as the risk of AVN consequent to this would be unacceptable.

PERTHES

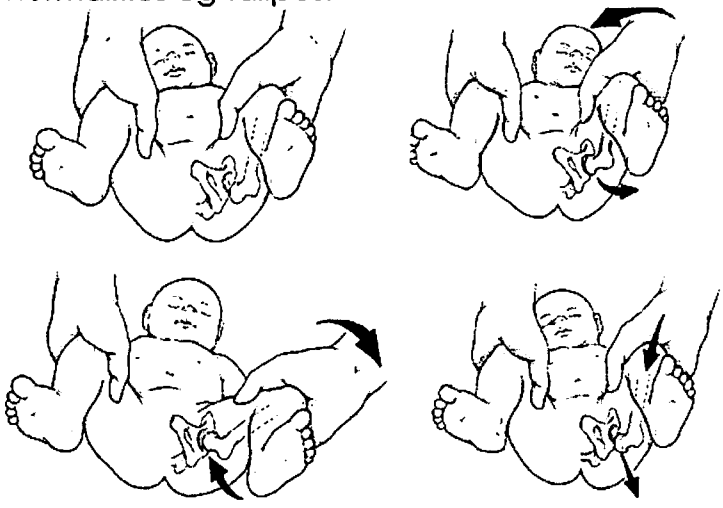
Self limited disease of femoral head characterized by bone necrosis, collapse and repair. Presents in the first decade with painless intermittent limp or hip pain with decreased abduction and internal rotation of hip. The cause of disruption of blood flow to femoral head is uncertain ie the lateral epiphyseal vessel.

Inx: Xray(not useful in early stages), bone scan(reveals reduced uptake), MRI.

Mx: depends on the predicted prognosis – age of patient, severity of destruction etc and varies from conservative mx of bed rest, non weightbearing, slings, abduction braces to surgical alternatives with the goal of containing the femoral head in the acetabulum.

DEVELOPMENTAL DYSPLASIA OF THE HIP

This is a term that refers to dislocated , subluxed or dysplastic(alteration in shape, size and organization) hip either congenital or in growing bones. Relatively common; 2 in 1000, risk factors: female, family history, breech presentation, certain races, neuromuscular conditions and associated with other congenital abnormalities eg talipes.



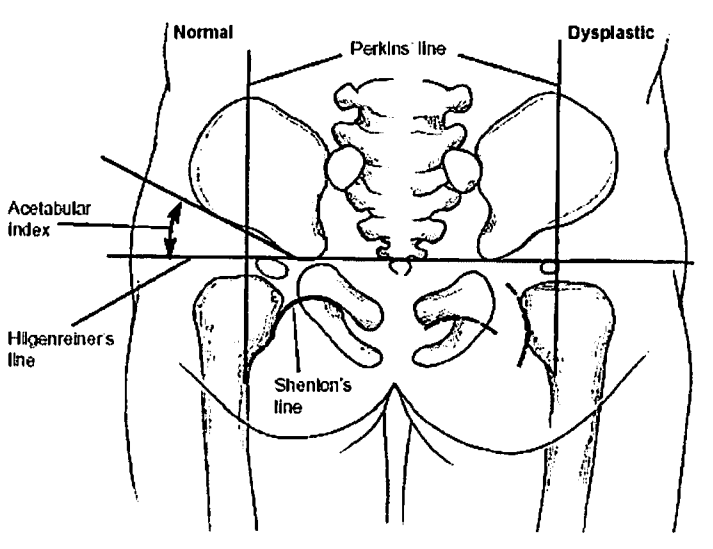
the key is to detect them ealy.

Early detection: Ortoloani's sign(reduced hip clicking on enlocation with abduction) or Barlow's sign (being able to reduce a hip with direct vertical pressure)- Other signs to look for is asymmetrical creases, shortening of femur and limited abduction of the hip .

Inx: Ultrasound is useful in the first 6 mths as most of the hip anatomy is cartilaginous, otherwise a plain xray is very helpful.

Note the following on the xray:

- femoral head smaller in size
- larger acetabular index
- disrupton of shenton's line



CT scans: very useful especially in confirming adequate hip enlocation postoperatively after application of hip spica or surgery. Should be booked preoperatively. On the slip state that only fine slices through the hip is required and if the child is in hip spica (if so no sedation is required)

MRI: harder to book but very sensitive in picking up any vascular disruption to the head

MANAGEMENT

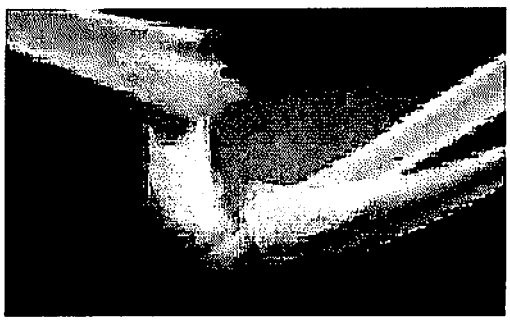
- 0-6mths: pavlik harness is the mainstay of treatment , if stable reduction is not possible after 2 weeks of treatment then EUA with closed or open reduction (psoas tendon and inferior capsule release).
- 6-12mths: EUA, open reduction , hip spica
- older ages: osteotomies may be the only option when bony abnormalities prevent concentric enclocations eg VDROs and pelvic osteotomies.

FRACTURES

WARD MX:

- pain: variable, most are pain free with stabilization. Humeral fractures are particularly painful as they are not in plaster . ensure adequate analgesia when sent home and get pain team involved in the complex ones.
- Compartment syndrome: elevation is crucial, watch out for unexpected pain, pain on passive movement and of course the 6Ps (pain, paralysis, paresthesia, pulseless, pale,painfully cold)
- Neurological injuries: The majority of nerve injuries are traction injuries in continuity and mx is expectant. Recovery is in few days for neuropraxias and few months in axonotmesis.

SUPRACONDYLAR FRACTUERS



Supracondylar fractures are common in kids peaking between 5-8 yr. The most common type is the extension type secondary to fall on outstretched arm, flexion type is rare and occurs with direct impact on the elbow. Classificsation for extension type- Gartland classification:

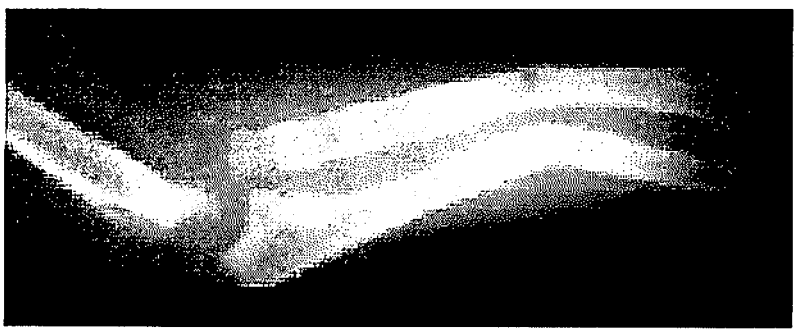
Grade I: non displaced

II:displaced with variable degree of angulation but the posterior cortex of the humerus is intact

III:completely displaced with no cortical contact

Mx depends upon the severity/grade and ranges from conservative mx to percutaneous pinning. With the K wires they must be removed in 3 weeks time in the outpatient clinic , we have had two patients who had K wires placed in other hospitals and they were left in situ for 6 weeks resulting in chronic osteomyelitis of the elbow.

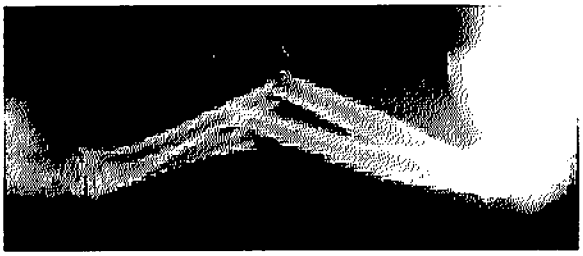
MONTEGGIA TYPE FRACTURES



The eponymous term "Monteggia fracture" is most precisely used to refer to dislocation of the proximal

radioulnar joint in association with a forearm fracture. It is the character of the ulnar fracture rather than the direction oft eh radial-head dislocation that is useful in determining the optimal treatment. Stable anatomic reduction of ulnar fracture results in anatomic reduction of radial head. The key to a good outcome after a monteggia fracture is early recognition of proximal radioulnar dissociation.

FOREARM FRACTURES



Three main types:

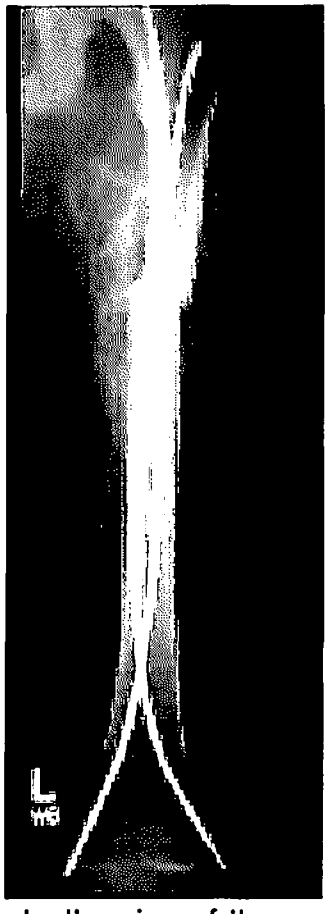
- Greenstick fractures: incomplete fractures with an intact cortex and periosteum on the concave side. Result of excessive rotational forces.
- Complete fractures of both forearm bones are classified by location –proximal, middle and distal third
- Distal radial metaphyseal fractures

Fractures are classified by location, completeness, angular, rotational deformity and fragment displacement. Such fractures are usually managed by LAMP (local anesthetic manipulation and plastering under Bier's block or more recently ketamine) or by GAMP (general anesthetic manipulation and plastering). Given that kids have a great remodeling capacities exact apposition is not always required. The importance of carefully molded plaster cannot be underestimated.
Patient's are usually admitted overnight for elevation and analgesia, sent home with 1 week review and a total of 6 week plaster immobilization.
In cases of open fractures, neurovascular injuries and failure of conservative manipulation open reduction and fixation (ORIF) may be necessary.

HUMERAL FRACTURES

Proximal type: majority are managed by simple immbolisation using a sling, collar and cuff or a hanging cast which is sometimes better tolerated as it distributes the weight on forearm and allows more stability. The fracture is allowed to heal under the force of gravity. Healing rapid -3 weeks because the proximal humeral physis contributes to 80% of humeral growth. ORIF is reserved for displacement of more than 50% or angulation of more than 30degrees in children less than 2 yrs of growth remaining.
Diaphyseal type: uncommon, in kids 3-12 yr exclude pathological cause eg cyst, mx as above.
Distal type: usually supracondylar type

FEMORAL FRACTURES

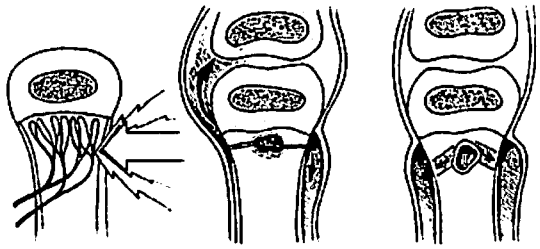


Femoral shaft fractures are frequent in children and adolescent. Almost all unite fairly rapidly and complications such a nonunion, deformity, leg-length discrepancy and neurovascular injuries do occur but fairly uncommon. Remember that a high percentage of femoral shaft fractures in kids less than 3 is secondary to child abuse so have a high index of suspicion. Management depends on age of child, type of fracture and injury type. Treatment options include traction, femoral casting, spica, external fixation, compression plate, intramedullary nail flexible or locked.

- age 0-5: immediate hip spica (within 24-48hr) if isolated shaft fracture and less than 1-2cm shortening. If mulitiple injuries and significant shortening traction for 3-10 days before delayed spica is performed. If open fracture external fixation.
- Age 6-11: as above however flexible nail and compression plates are other option depending on injury type , child and family. Spica cast not usually recommended for those above 8, high BMI, communicated fracture or multitrauma. Locked intramedullary nail is contraindicated due to the size of the nail compare to the femoral canal and thus risk of vascular compromise.
- Above 12, patients are at risk of knee stiffness and deformities if casted, internal fixation is preferable as It also allows early discharge and mobilization.

POSTOP CARE: analgesia, physiotherapy, consider DVT prophylaxis in near adult groups. Clexane needs approval from the drug usage committee NOT the hematology unit.

OSTEOMYELITIS



Acute hematogenous osteomyelitis in paediatric population usually occurs in the first decade, it is possible that combination of trauma and bacteremia favours the development of infection in the **metaphyseal** venous sinusoids (as illustrated above), if not treated early the infection can track down and elevate the periosteum and if intra-articular spread to the joint. Further progress can lay down new bone /involcurm and formation of dead bone or sequestrum.

It classically presents with bone pain and fever, in infants fever and inability to use a limb, with raised inflammatory markers and WCC, on examination swelling and tenderness are hallmarks. However lack of fever and normal WCC should not deceive you. CRP is elevated in majority of cases and reaches its peak by day 2, compared to ESR which lags behind clinical improvement; **CRP** is a more reliable marker to follow to monitor clinical response, with normal values being reached within 1 week of treatment. If CRP on day 3 is more than1.5 times the level on admission then suspect associated septic arthritis. Blood culture is positive in less than 50% of patients.

Differential diagnosis include cellulitis, tumour, trauma and septic arthritis. One must remember that septic arthritis can coexist with osteomyelitis especially in infants and bones with an intra-articular metaphysic eg proximal radius, humerus and femur.

Other investigations for example bone scan are useful for localization, identification of multiple sites and associated septic arthritis. Remember that bone scan is negative in at least 20% of patients and thus clinical diagnosis is more important. MRI is excellent in diagnosis of more difficult cases, usually not used as a routine investigation but useful in cases of chronic osteomyelitis and exclusion of more sinister causes. Don't forget simple investigations such as xray useful to exclude trauma and may show joint swelling in septic arthritis, radiolucency is the first xray sign in osteomyelitis due to relative osteopenia (not visible until 7-10 days). Ultrasound useful for detecting joint effusion and subperiosteal collections.

TREATMENT

In infants and children coagulase +ve staphylococcus aureus is the pathogen in 90% of cases whereas in infants Gr B streptococcus and

gram-ve should be considered. In almost all cases except septic arthritis IV high dose **flucloxacillin (50mg/kg)** is started ASAP, there is an argument for monitoring LFTs in such cases, though there is no guideline ,in one of my patients we had to switch to cephalexin as her LFTs were deranged.

Patients are kept on **IV antibiotics** until the child has been afebrile for at least 24 hrs (it still varies 3-5days is norm) and switched to oral only if there is a clinical and laboratory response. One must ensure that oral intake is adequate and the patient should at least have **2 successful oral** antibiotic doses before discharge. You will find that kids will hate oral flucloxacillin mixtures as they taste terrible, alternative would be to mask their taste in cordials (which usually doesn't work) or **cephalexin** (strawberry flavored granules!), ensure that whatever antibiotics the highest safe dose possible is prescribed, though cephalexin has poorer 'bone permeability'. If you are lucky and you have grown the bug and if it is sensitive to flucloxacilin and ciprofloxacillin but resistant to penicillin you can still assume that it is sensitive to cephalexin.

A total of **6weeks** of antibiotics is required (IV+oral), authority is required for the 4 weeks (maximum allowable) on discharge , remember antibiotic bottles expire in 14 days so ask for a repeat authority, specify that you want powder for mixture (fluclox) or granules (cephalexin). 250mg/5ml is the usual concentration and they give them 100 ml bottles, in many cases you need authority for 10-15 bottles. Don't forget to give them a blood slip for repeat inflammatory markers a day before their outpatient appointment (usually in 2-3weeks).

In cases where medical treatment fails to achieve improvement consider complications for eg subperiosteal abscess, septic arthritis or wrong diagnosis.

Things to consider in **neonatal osteomyelitis** (less than 18mths):

- causative organisms are different eg streptococcus, gram –ve
- clinical presentation may be subtle with normal temperature and inflammatory marker
- infection spreads more rapidly and can be multifocal due to their immature immune system
- the metaphyseal vessel penetrate directly into the chondroepiphysis allowing an infection to rapidly spread into the joint and destroy it, thus early recognition and treatment will prevent sequele such as growth arrest secondary to physeal damage.

SEPTIC ARTHRITIS

Similar to osteomyelitis in presentation and management except that immediate surgical drainage and washout is crucial to prevent joint damage.. Hip and Knee joints are common sites to which the pathogens reach either hematogenously or via metaphysis.

In hip joint inflammatory response forms an effusion which increases the intracapsular pressure resulting in pain which is minimized if the hip is held in external rotation, abduction and mild flexion (frog like). A very reliable sign in septic arthritis of a joint is that any movement of the joint will cause exquisite pain and guarding. ESR will be high in most cases in 24-48 hrs whereas CRP in 6-8hrs. Ultrasound is the first line investigation especially in the hip where joint swelling is not easily palpable (very sensitive but not specific), however if clinically the diagnosis is conclusive time is not wasted and theatre booked.

Operation involves obsessive lavage of the joint with at least 1 L of normal saline, synovial fluid is sent for M/C/S to increase the sensitivity synovial biopsy and slide for immediate gram stain is also undertaken. During my time there I had not even one patient in whom they were able to grow a bug from specimen obtained intraoperatively , infact studies have shown only 50% sensitivity, thus It is important not to start antibiotics until the surgical drainage is undertaken as the yield for growing anything would become even lower. Ddx : transient synovitis of hip, psoas abscess, etc.

Treatment similar to osteomyelitis except that duration is 3 weeks and similar antibiotic is used ,don't forget in neonates staphylococcus is NOT the common pathogen.

REFERENCES

1. Resident Handbook 2002
2. Englehardt et al 'Tramadol for pain relief in children undergoing tonsillectomy: a comparison with morphine', Paediatric Anesthesia, 2003, 13:249-252
3. Nishina et al 'Clonidine in Paediatric Anesthesia', Paediatric Anesthesia 1999, 9:187-202
4. Broome et al 'The use of tramadol following day case oral surgery', 1999, 54:266-296
5. Joshi et al 'Analgesic effect of clonidine added to Bupivacaine 0.125% in paediatric caudal blockade', Paediatric Anesthesia 2004, 14:483-486
6. Tobias JD, Deshpande JK, Paediatric pain management for primary care, 2nd Edition, Mosby year book 2005
7. Dahner Le , Mullis BH. 'Effect of nonsteroidals anti-inflammatory drugs on bone formation and soft tissue healling', J Am Acad Orthop Surg . 2004 May-Jun; 12:139-43
8. Leih Lai et al . 'Syndrome of inappropriate antidiuretic hormone secretion in children following spinal fusion', Crit Care Med, 1999, 27: 622-627.
9. Brazel PW, Mcphee IB 'Inappropiate secretion of Antidiuretic hormone in postoperative scoliosis patients: the role of fluid management', Spine, 1996, 21: 724-727
10. Richard J et al ' The syndrome of inappropriate antidiuretic hormone secretion and its effect on blood indices following spinal fusion' Spine, 1989, 14: 722-726
11. Guille et al, ' Developmental dysplasia of the hip from birth to six months', J Am Acad Orthop Surg 1999:8: 232-242.
12. Guille et al, ' Developmental dysplasia of the hip from birth to six months', J Am Acad Orthop Surg 1999:8: 232-242.
13. Ring et al, 'Monteggia fractures in children and adults', J Am Acad Orthop Surg 1998:6:215-224.
14. Flynn JM & Miller F, 'Hip disorders in Cerebral Palsy', J Am Acad Orthop Surg, 2002;10:108-209
15. Sucato et al, 'Septic arthritis of hip in children', J Am Acad Orthop Surg, 1997; 5:249-260.
16. Dormans et al, 'Paediatric Hematogenous Osteomyelitis: New trends in presentation, Diagnosis and treatment' J Am Acad Orthop Surg, 1994:2; 333-341.
17. Skaggs et al, 'legg-calve-perthes ',J Am Acad Orthop Surg 1996:4;19-16.
18. Stanitiski CL, 'Acute slipped capital femoral epiphysis: treatment alternative', J Am Acad Orthop Surg 1994:2;96-106.

19. Beaty JH, 'Femoral shaft fracture in children and adolescent', J Am Acad Orthop Surg 1995;3:207-217