Children's Health Queensland Hospital and Health Service

Rotationplasty

Queensland Paediatric Rehabilitation Service – Limb Difference

Dr Sasaka Bandaranayake and Shani Jackman (Shail Maharaj)

November 2025

Queensland Children's Hospital+

CELEBRATING 10 YEARS

Queensland Government

Children's Health Queensland Hospital and Health Service pays respect to the Traditional Custodians of the lands on which we have the privilege to work on.

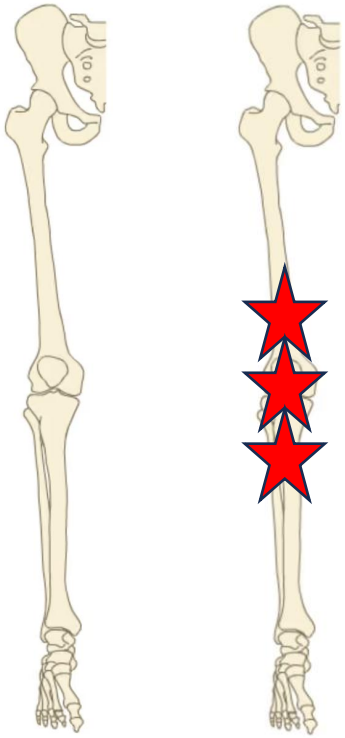
We acknowledge and pay our respects to Aboriginal and Torres Strait Islander Elders past, present and emerging.

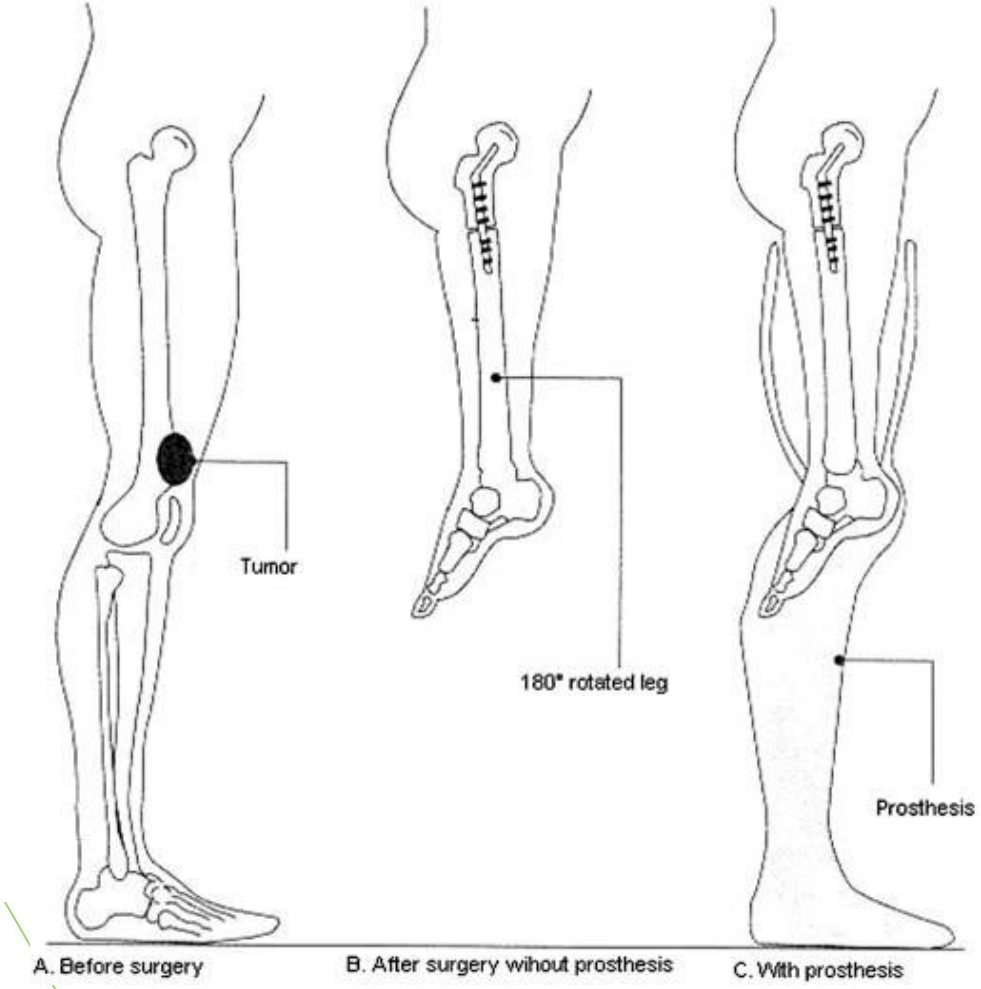
Acknowledgment of our Patients and Families

We would like to acknowledge our patients and families for providing consent for our images today, openly sharing their stories and supporting others that come after them.

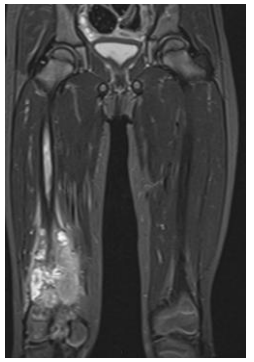
We would also like to acknowledge all differences that make us all unique and who we are.

What is it ?




Tumor
180° rotated leg
Prosthesis
A. Before surgery
B. After surgery wihout prosthesis
C. With prosthesis

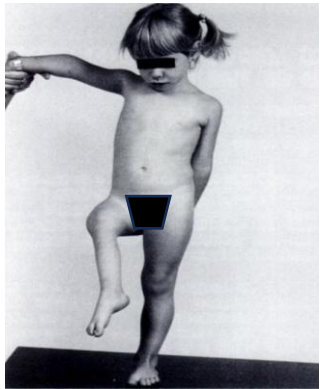
History of Rotationplasty



1930 – Borggreve - Femoral Deficiency in **TB**

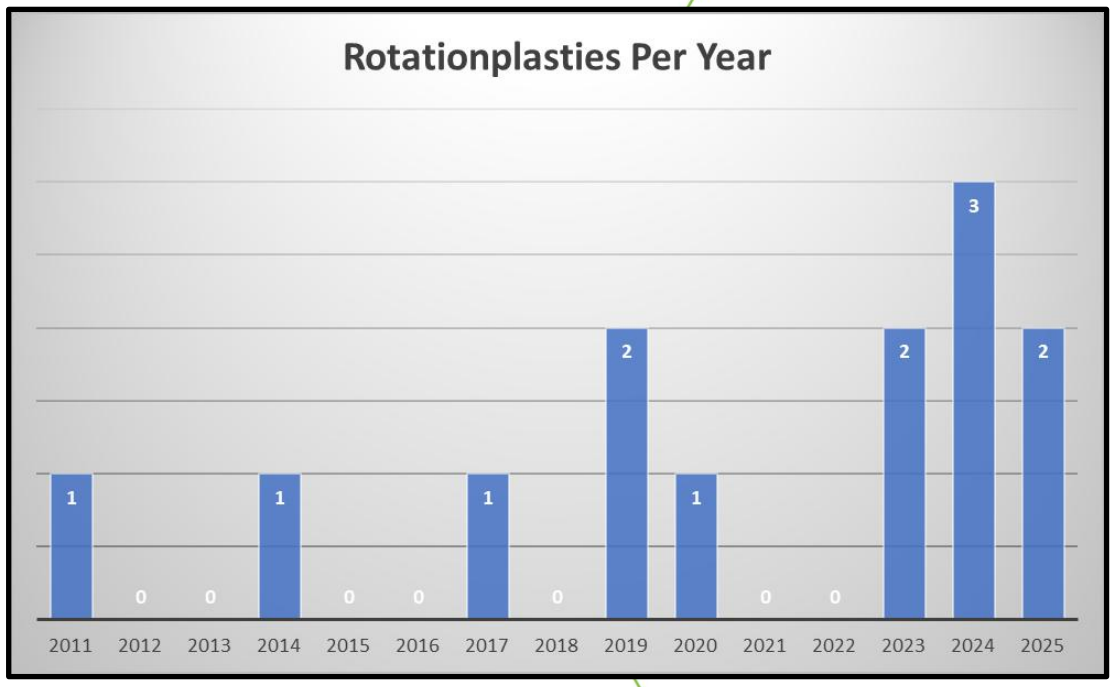
1981 – Salzer et al – **Oncological Resections**

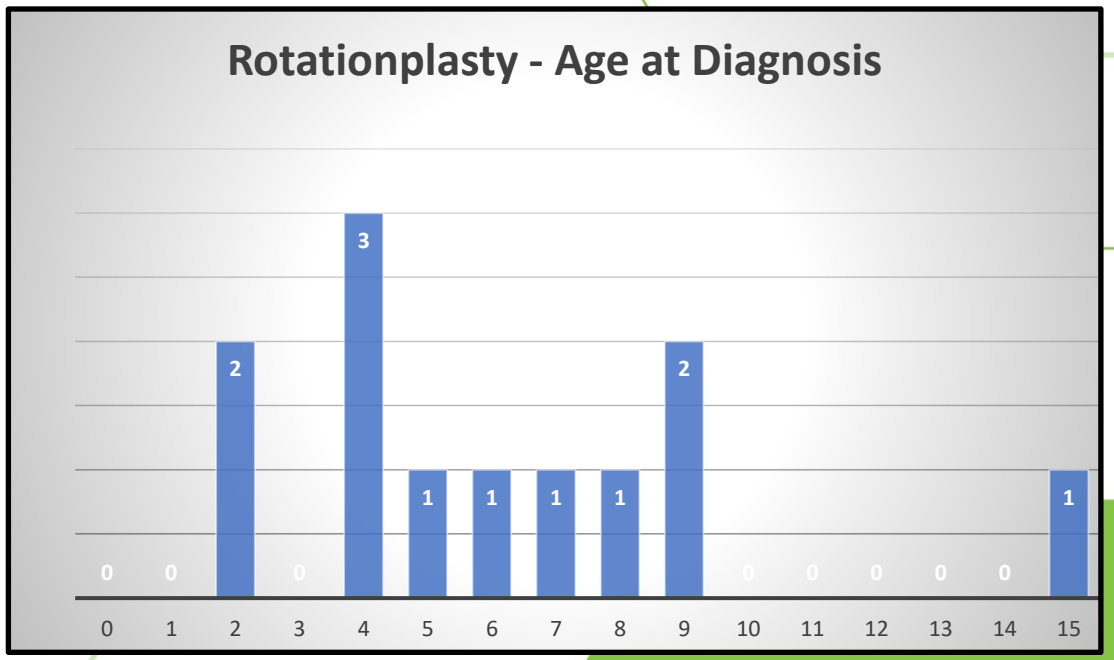
1950 – Van Nes – Mx of **Proximal Focal Femoral Deficiency**



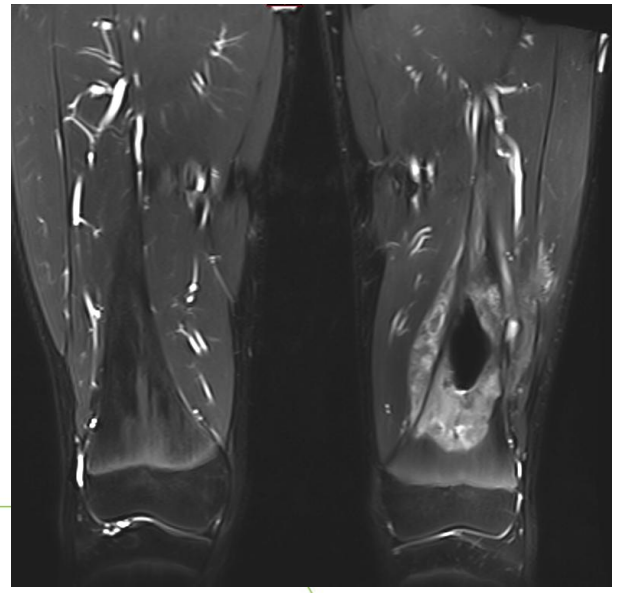
Our Stats

- First Rotationplasty in Brisbane 2011
- 11 children since 2011, with 2 planned for 2025
- Types of tumours
  - Osteosarcomas (9)
  - Ewing (2)
  - Spindle Cell Rhabdomyosarcoma (1)
- Age at time of diagnosis
  - Youngest 2
  - Oldest 15
  - Most present between 2-9 years
- Failed Rotationplasty (2)
  - Hip disarticulation
  - High femoral amputation





Options To Consider



Limb Reconstruction

Endoprosthesis

High Amputation

Rotationplasty

Leg Length Discrepancy

Loosening, Infection, Activity limitation

High Energy Cost

Cosmesis

Who's an appropriate surgical candidate ?

Indications

- The lesion being in the right place
- The Growing Child - (Skeletally Immature)*

Contraindications

- Dysfunctional Sciatic Nerve / Sciatic Nerve involvement with tumour

Is a rotationplasty ‘better’ than the other options ?

Function

Ginsberg JP, Rai SN, Carlson CA, et al. A comparative analysis of functional outcomes in adolescents and young adults with lower-extremity bone sarcoma. Pediatr Blood Cancer. 2007; 49:964–969. [PubMed: 16921515]

Lindner NJ, Ramm O, Hillmann A, et al. Limb salvage and outcome of osteosarcoma: The University of Muenster experience. Clin Orthop Relat Res. 1999; 358:83–89. [PubMed: 9973979]

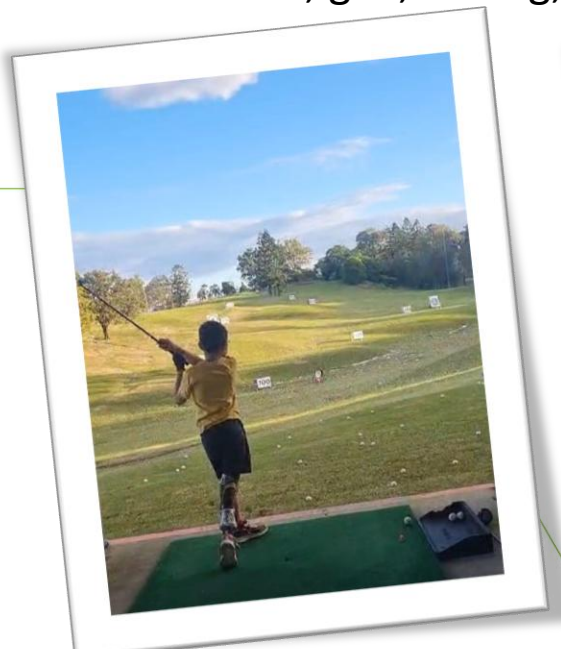
Akahane T, Shimizu T, Isobe K, et al. Evaluation of postoperative general quality of life for patients with osteosarcoma around the knee joint. J Pediatr Orthop B. 2007; 16:269–272. [PubMed: 17527105]

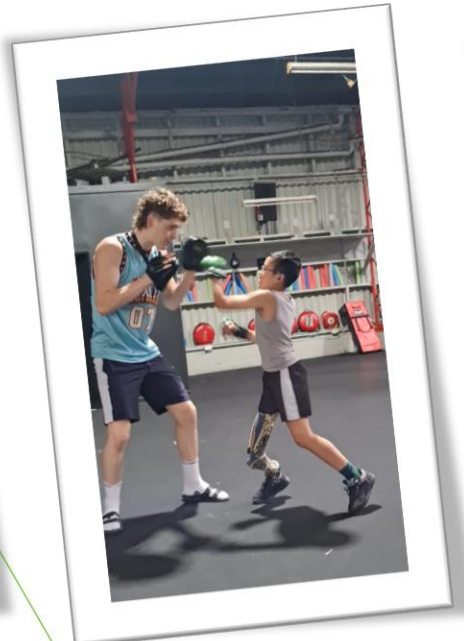
Cosmesis

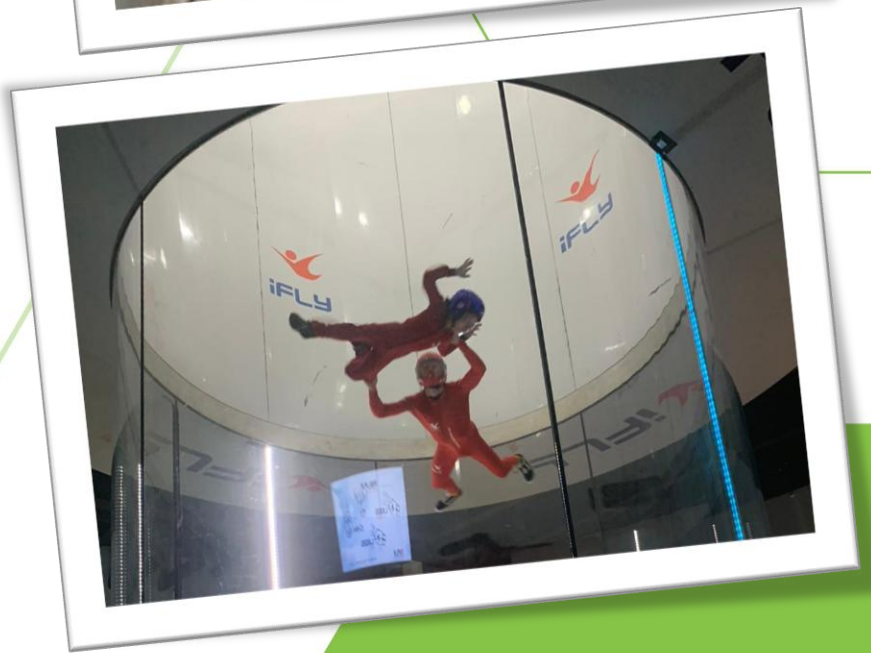
Rodl RW, Pohlmann U, Gosheger G, et al. Rotationplasty—Quality of life after 10 years in 22 patients. Acta Orthop Scand. 2002; 73:85–88. [PubMed: 11928918]

Benefits

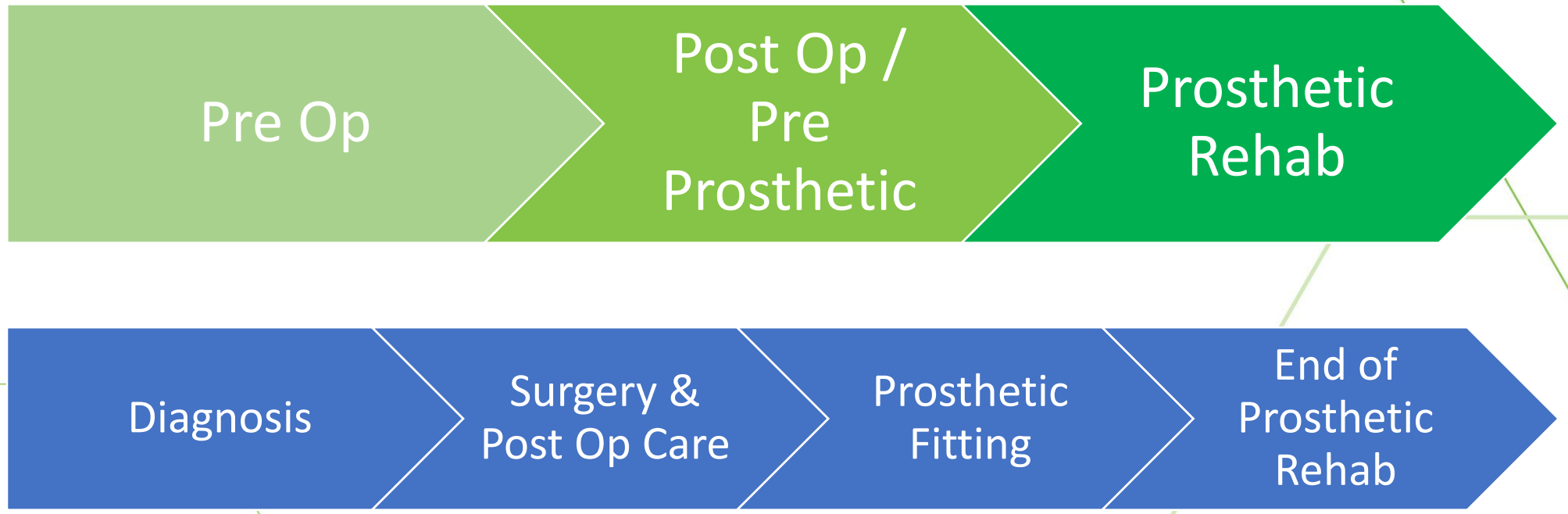
- Absence of Phantom Pain/Sensation
- The bones and tissues continue to grow
- Reduced energy cost (similar to Symes level)
- Good functional results
  - Better results than those who have a high-level amputation
  - Able to live more actively than those with endoprostheses
  - Tennis, horse riding, athletics, rollerblading, cycling, downhill skiing, soccer, golf, boxing, MMA, rock climbing, etc

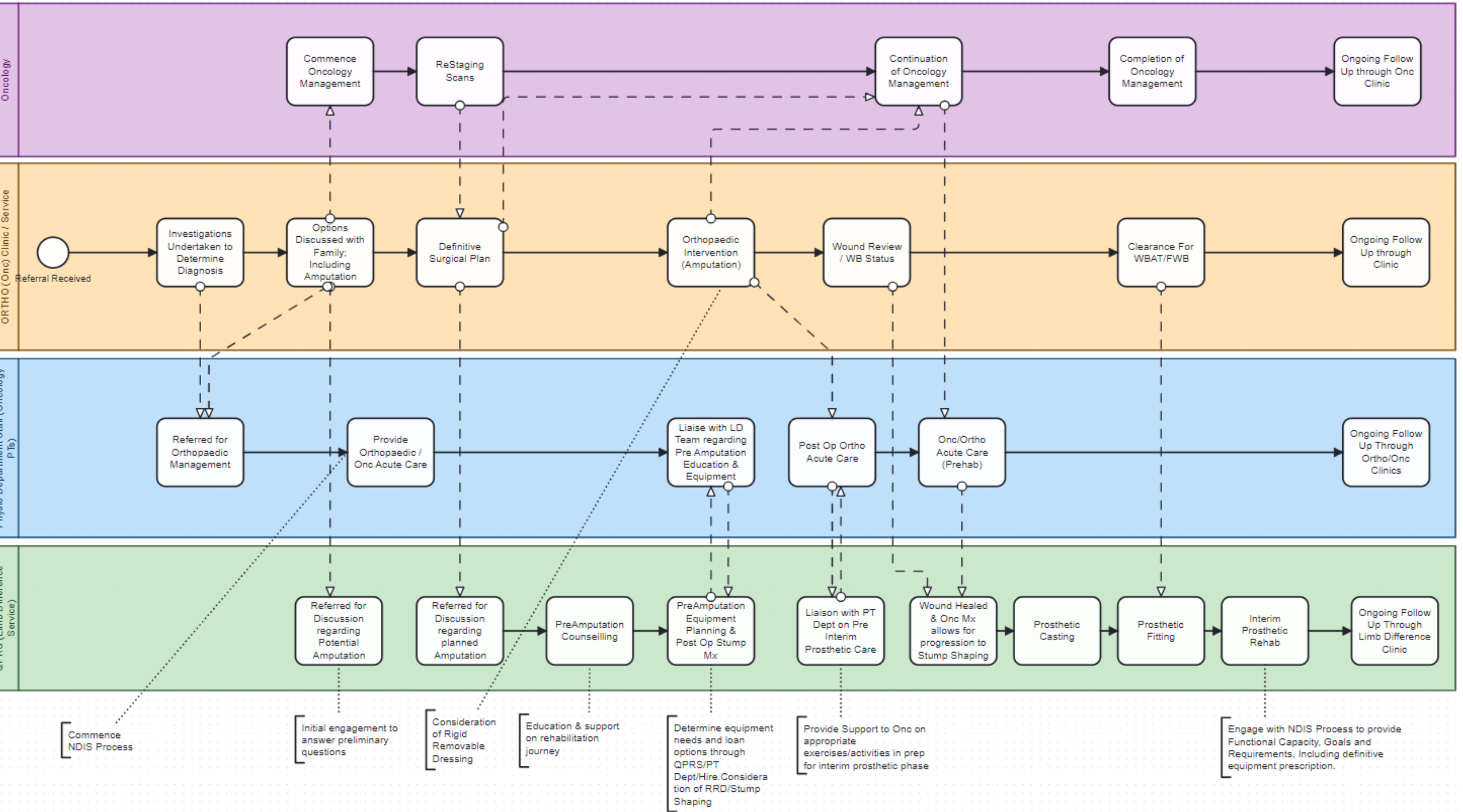




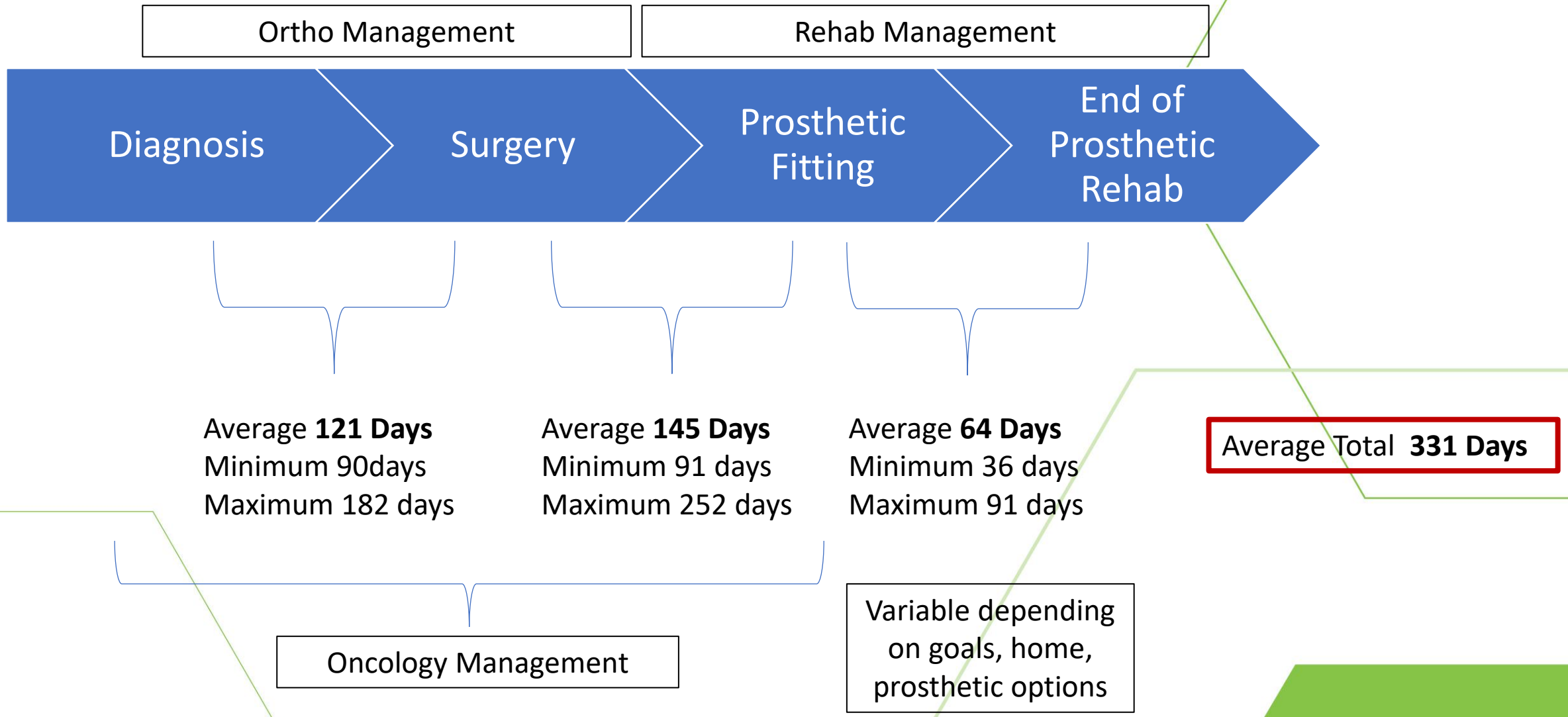


Phases of Care



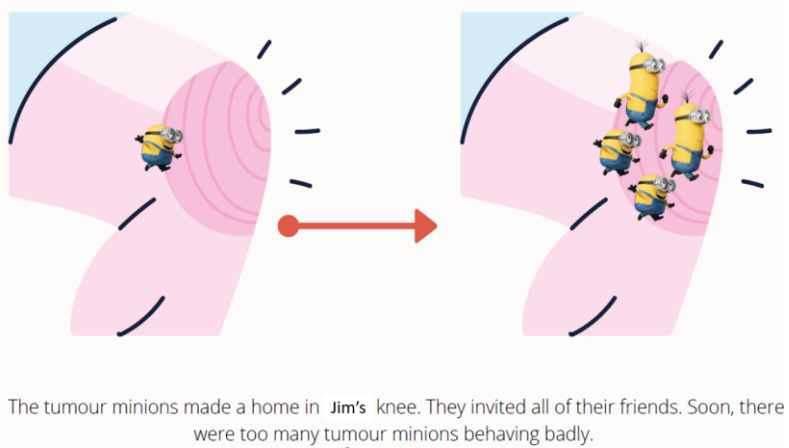

Oncology
Commence Oncology Management
ReStaging Scans
Continuation of Oncology Management
Completion of Oncology Management
Ongoing Follow Up through Onc Clinic
ORTHO (Onc) Clinic / Service
Referral Received
Investigations Undertaken to Determine Diagnosis
Options Discussed with Family; Including Amputation
Definitive Surgical Plan
Orthopaedic Intervention (Amputation)
Wound Review / WB Status
Clearance For WBAT/FWB
Ongoing Follow Up through Clinic
Physio Department Staff (Oncology PTs)
Referred for Orthopaedic Management
Provide Orthopaedic / Onc Acute Care
Liaise with LD Team regarding Pre Amputation Education & Equipment
Post Op Ortho Acute Care
Onc/Ortho Acute Care (Prehab)
Ongoing Follow Up Through Ortho/Onc Clinics
QPRS (Limb Difference Service)
Referred for Discussion regarding Potential Amputation
Referred for Discussion regarding planned Amputation
PreAmputation Counselling
PreAmputation Equipment Planning & Post Op Stump Mx
Liaison with PT Dept on Pre Interim Prosthetic Care
Wound Healed & Onc Mx allows for progression to Stump Shaping
Prosthetic Casting
Prosthetic Fitting
Interim Prosthetic Rehab
Ongoing Follow Up Through Limb Difference Clinic
Commence NDIS Process
Initial engagement to answer preliminary questions
Consideration of Rigid Removable Dressing
Education & support on rehabilitation journey
Determine equipment needs and loan options through QPRS/PT Dept/Hire.Consideration of RRD/Stump Shaping
Provide Support to Onc on appropriate exercises/activities in prep for interim prosthetic phase
Engage with NDIS Process to provide Functional Capacity, Goals and Requirements, Including definitive equipment prescription.

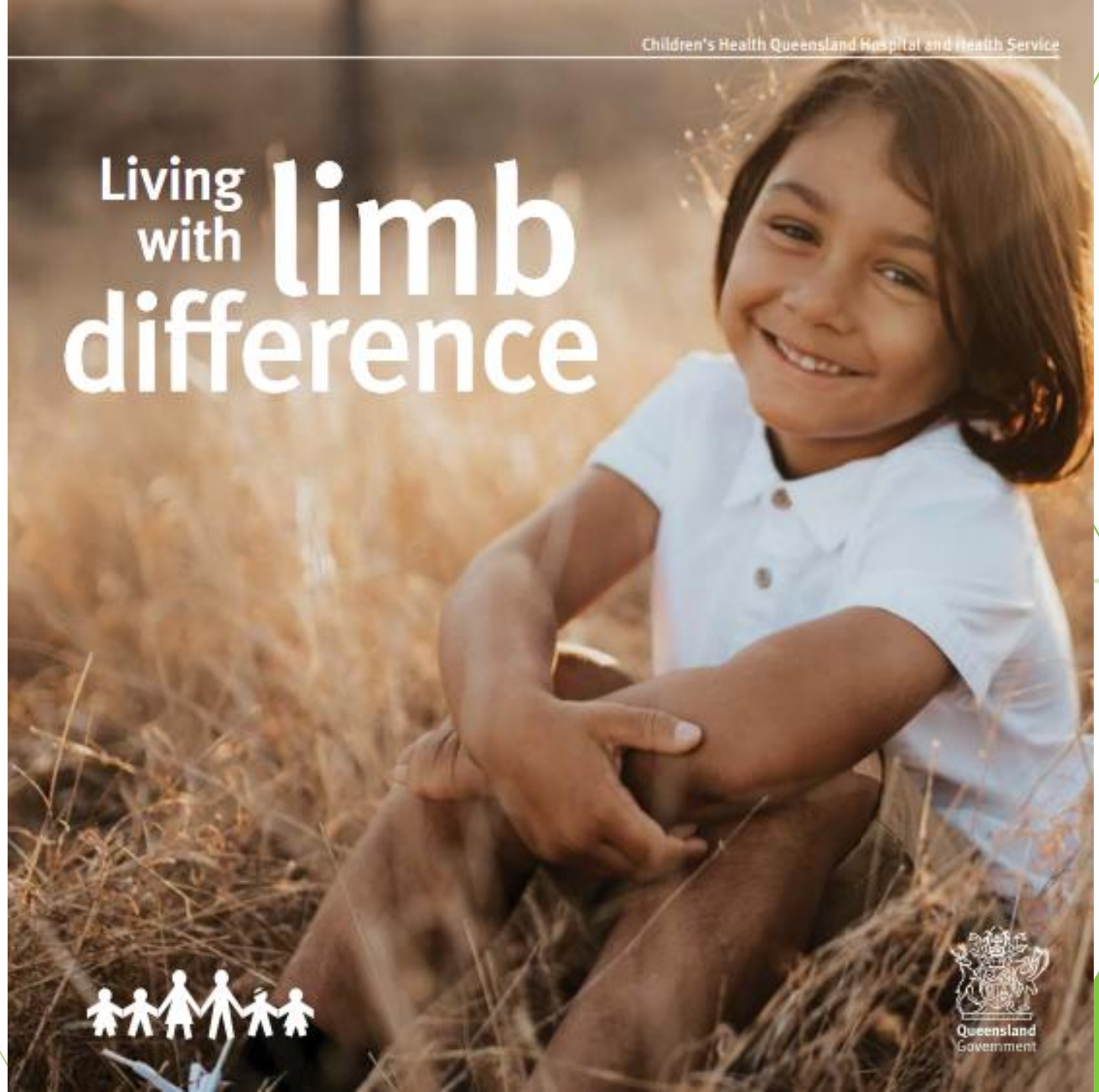
Timeline


Ortho Management
Rehab Management
Diagnosis
Surgery
Prosthetic Fitting
End of Prosthetic Rehab
Average **121 Days**
Minimum 90days
Maximum 182 days
Average **145 Days**
Minimum 91 days
Maximum 252 days
Average **64 Days**
Minimum 36 days
Maximum 91 days
Average Total **331 Days**
Oncology Management
Variable depending on goals, home, prosthetic options

Pre Op

- <u>Pre Op Counselling</u>
  - Education and psychosocial Support
  - Meeting other patients and families
- <u>Surgical Planning</u>
  - Surgery planning
  - Home – Safety, Access, Participation
  - Equipment
  - Skills Training – mobility aids
  - Optimise physical functioning




Children's Health Queensland Hospital and Health Service
Living with limb difference
Queensland Government

Jonty

Rotationplasty

By Robyn Farley (Jonty's mother)

Looking at our happy, well-adjusted 13-year-old boy right now is like looking at any regular teenager – technology addicted, carefree and becoming cheeky, focused on himself and his friends, whom he communicates with constantly through social media whenever he's not at school.

We no longer notice his right foot, which is aimed backwards at the level where his knee should be. When he wears his prosthetic leg, it looks more like a brace on an existing limb than a prosthetic on a leg that has an ankle in place of a knee.

At school, Jonty's a bit of a legend – known even to the higher grade kids as the boy with the fake leg who rides a Segway to school, and has a key to the lift (both to the envy of many, we think). His ability to do pretty much everything they can, and his audacious nature has made him fit right in and become accepted for who he is.

While he has certain privileges to assist him in his everyday life, he is fully able to climb the three flights of stairs to his classroom and walk the two kilometers to school and back each day.

In fact, the rotationplasty surgery is so good that there is really nothing Jonty can't do, if he puts his mind to it. While Jonty does tire quicker than other kids his age, he can walk, run, play sport, climb, dance and swim. In fact, in the pool he excels, beating half his grade across the lengths despite them being able-bodied. Some of these activities, like swimming, he chooses to do without his prosthetic, and often his ability is even greater without it. Jonty can do just about anything an able-bodied thirteen can do, to varying competencies, with or without his artificial limb.

While he isn't a very active and outdoorsy boy, just by his nature, he does love walking his two dogs, swimming, going to the beach, jumping on the trampoline and wrestling with his little sister. He has had great fun over the years at camps and on family holidays, doing rock climbing, horse riding, canoeing, obstacle courses and hiking up mountains. He also participates annually in his school athletics and swim carnival days. He's looking forward to continuing to do well through high school, and living his best life with his friends and family, who are all immensely proud of him and support him all the way.

Abbey

Rotationplasty

By Abbey's family

Abbey is a bright, engaging nine-year-old. She has always lived at Wicklow Station (our sheep and cattle grazing property), 45 kilometers west of Augathella, in western Queensland.

In July 2013, Abbey and her Mum, Pen, were visiting good friends at the neighbouring property when Abbey fell onto the lawn and broke her right leg. This was the first indication that there was something wrong with Abbey's health. She was flown to the Queensland Children's Hospital in Brisbane that night by the Royal Flying Doctors Service. Days later, we were informed that cancer had eaten into Abbey's bone, causing her leg to break.

While we were aware of the seriousness of her condition, it wasn't until sometime later that it became apparent just how much Abbey's life was at risk.

Over the following months, Abbey underwent chemotherapy, full body radiation, and the amputation of her right leg at the hip. The surgical team performed a procedure called a rotationplasty. The best way to describe the outcome is that her leg from under the knee, which had not been affected by the cancer, was saved, rotated and placed into her hip.

The result allows her right ankle to act as a knee, which gave her greater mobility once her prosthesis was fitted. This all occurred within six months of Abbey being diagnosed. The following nine months saw more chemotherapy and the introduction of the rehab team. In October 2014, Abbey was deemed to be in remission and we were able to take her home, where she was met by her very best friend – her dog, Buzz the Jack Russell.

While we still had to make regular trips to Brisbane, Abbey slipped back into country life with ease. In 2015, Abbey joined the Augathella play group. This group of children has stayed largely in touch, and have moved through to year four together at Augathella State School. At school, Abbey joins in all the activities. Apart from school work, Abbey particularly enjoys spending time with her friends, music, art and sport. Her favourite sports are swimming and ball games.

It's a 90 kilometre round trip to go to school each day, but Abbey gets time to enjoy rural life as well. After school, on weekend and on holidays, Abbey helps our family with whatever it is that needs doing around the property. She musters on a motor bike, drives a buggy, rides a horse for fun, and helps with shearing and lamb marking. It's not unusual to see Abbey in her school uniform, helping on the shearing boards after school.

Abbey has had some big challenges in her young life, but she has met them bravely, with good humour and a maturity well advanced of her age. What advice would Abbey give to others facing challenges like her own? *"Be confident about your treatment. Be brave, and after your procedures make sure you have a go at everything".*

Nathan

Amputated left leg (hip disarticulation)

By Jill Pukallus (Nathan's mother)

Growing up on a farm in a household of competitive boys, where pushing each other's limits (and buttons) is a regular day, it was only natural for Nathan, as the youngest brother, to quickly learn resilience; a trait which he would really need in the year of 2017.

A year spent in and out of hospital, receiving treatment for what was initially just a small lump in his leg. Nathan's one goal that year was to beat cancer so that he could return to school the following year and graduate with his mates. Along with the support of family, friends and teachers, Nathan completed year 11 in hospital amid chemotherapy and surgeries, fulfilling his goal.

Nathan quickly learned to adapt with one leg and continued his life as a normal 17-year-old; riding his bike to the bus, getting his driver's licence and graduating at the end of 2018.

In his last year of school, Nathan went on to complete a Certificate III in Fitness, topped his English class and achieved an Academic Excellence Award.

Nathan now enjoys life working on the farm, camping with mates and maintaining his fitness and strength. He continues to push his physical limits, both in his prosthesis and without it. Climbing grain silos, landing flips on the trampoline, canoeing, indoor rock climbing and swimming are just a few of Nathan's physical pursuits to date, and he endeavours to add to this list.

Surgery

- Remove tumour
- Preserve neurovascular structures
- Technique to minimise the differences in circumference between the proximal and distal ends (femoral/tibial).
- Affix the distal segment to the proximal segment
  - Achieve best length and kneekle centre of rotation to match the contralateral knee at skeletal maturity
  - Align rotation to ensure kneekle is biomechanically aligned
- Stop proximal fibula growth (resect/epiphysiodesis)
- Debulking the intercalary segment
- Connecting of muscles to preserve ‘neo knee’ or ‘kneekle’ function which depends on where the resection has occurred

Types of Rotationplasty

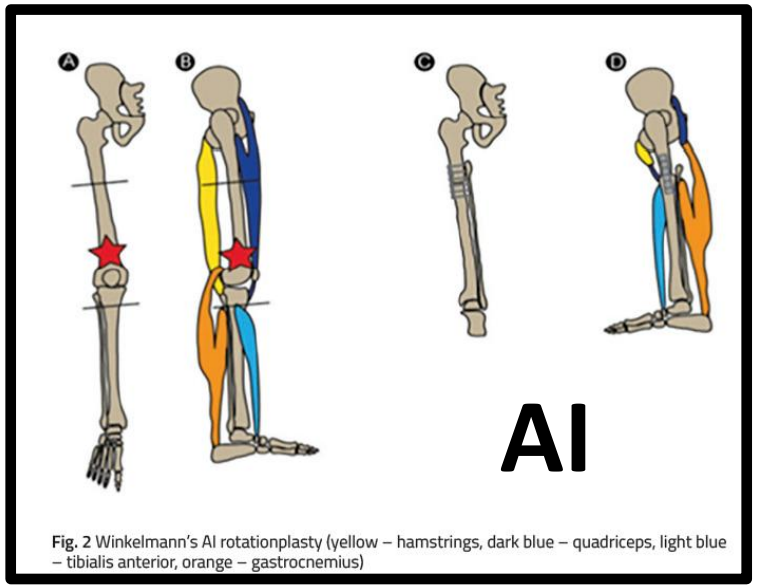
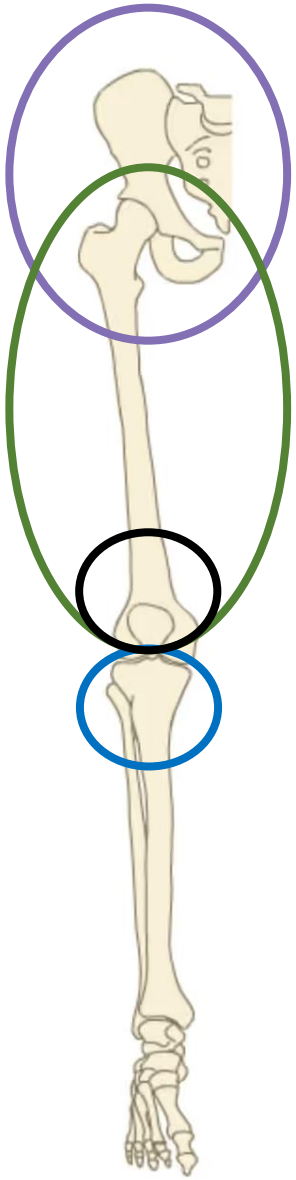


Fig. 2 Winkelmann's AI rotationplasty (yellow – hamstrings, dark blue – quadriceps, light blue – tibialis anterior, orange – gastrocnemius)

CHQ N=9



CHQ N=2

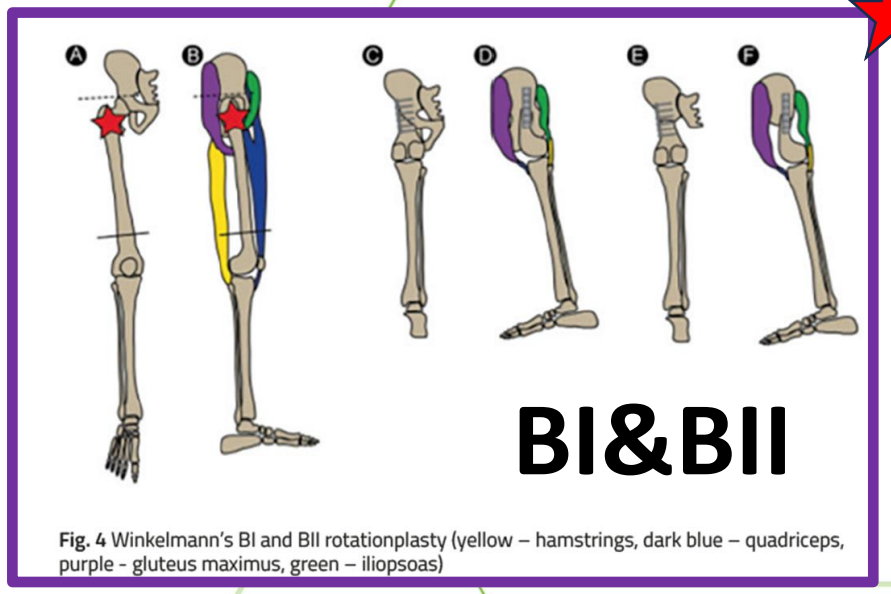


Fig. 4 Winkelmann's BI and BII rotationplasty (yellow – hamstrings, dark blue – quadriceps, purple - gluteus maximus, green – iliopsoas)

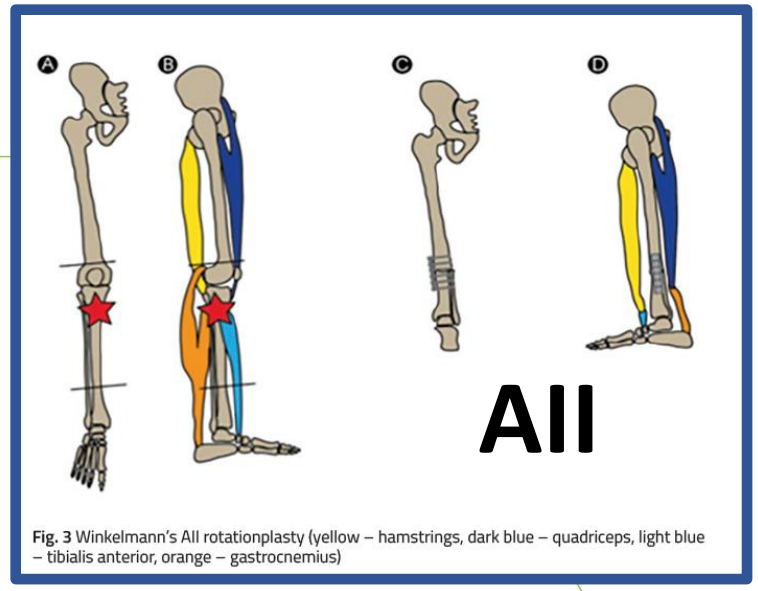
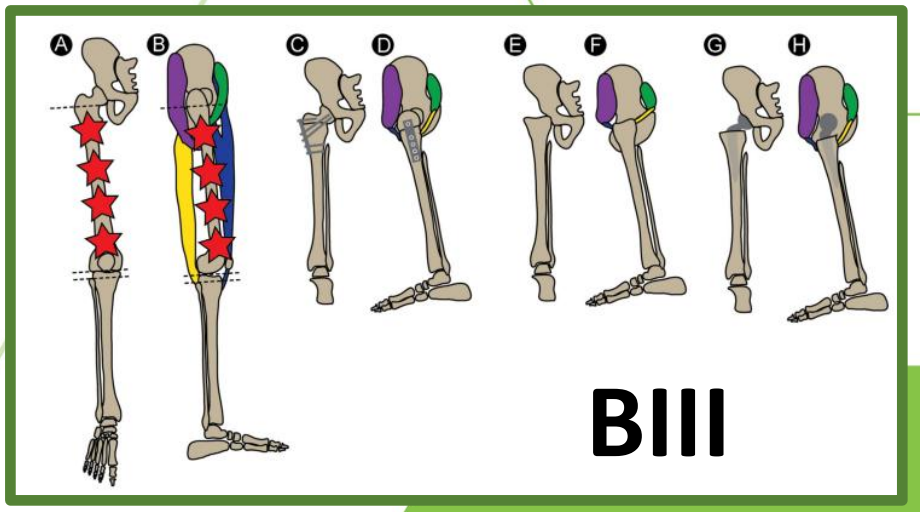


Fig. 3 Winkelmann's AII rotationplasty (yellow – hamstrings, dark blue – quadriceps, light blue – tibialis anterior, orange – gastrocnemius)



Post Op / Pre Prosthetic

- Vascularity and pulses
- Wound care and healing
- Pain management
- Nerve function and sensation
- Range of motion and muscle length
- ? To immobilise or not

- Ongoing psychological support

Complications

- Vascular / Compartment syndrome
- Delayed healing/necrosis
- Transient or permanent peroneal nerve palsy
- Pseudoarthrosis, non union, rotational malalignment
- Tumour recurrence
- Limb length discrepancy
- Pain

Prosthetic Rehab

1. Wounds are healed and leg is stable in shape/volume
2. Weight bearing OK from ortho/onc
3. Prosthetic casting and fitting
4. Length and strengthening ++
5. Weight bearing
6. Balance
7. Gait – learning to use muscles for different actions
   - with aids, with less aids, with no aids
8. Return to sport

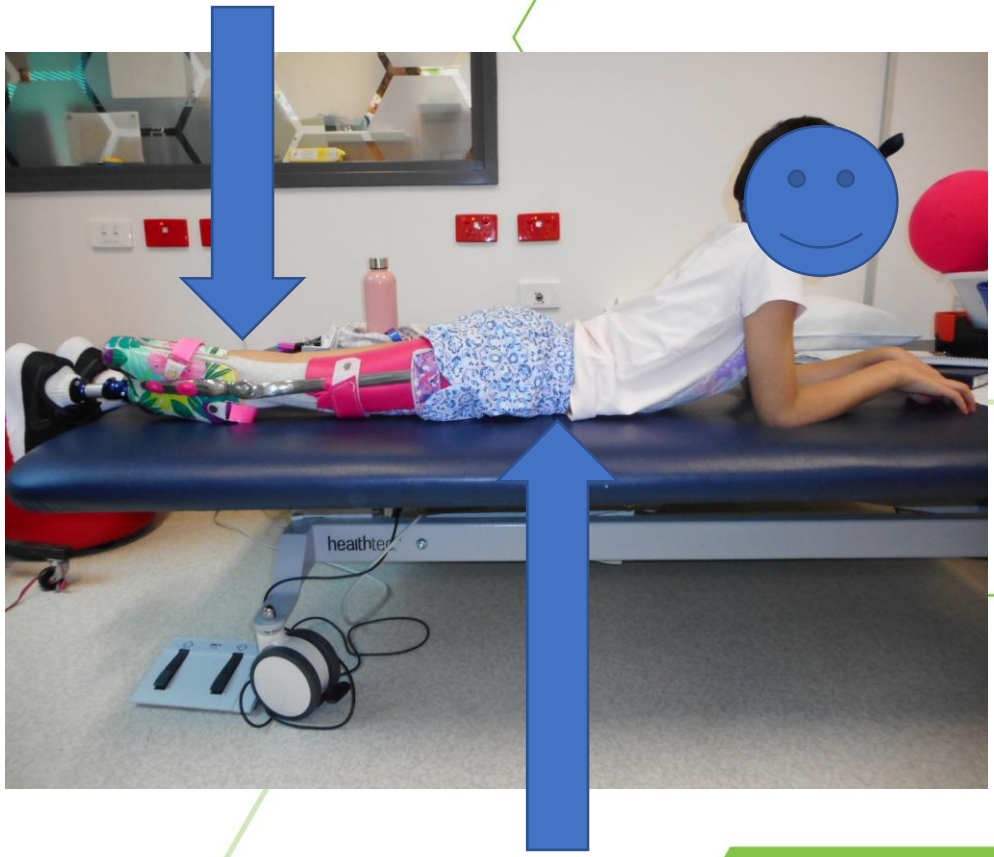
‘Kneekle’ passive and active ROM

- PF = knee extension – goal is 70°
- DF= knee flexion- goal is 20°

Prosthetic Rehab

Range
Strength
Neuro Mapping

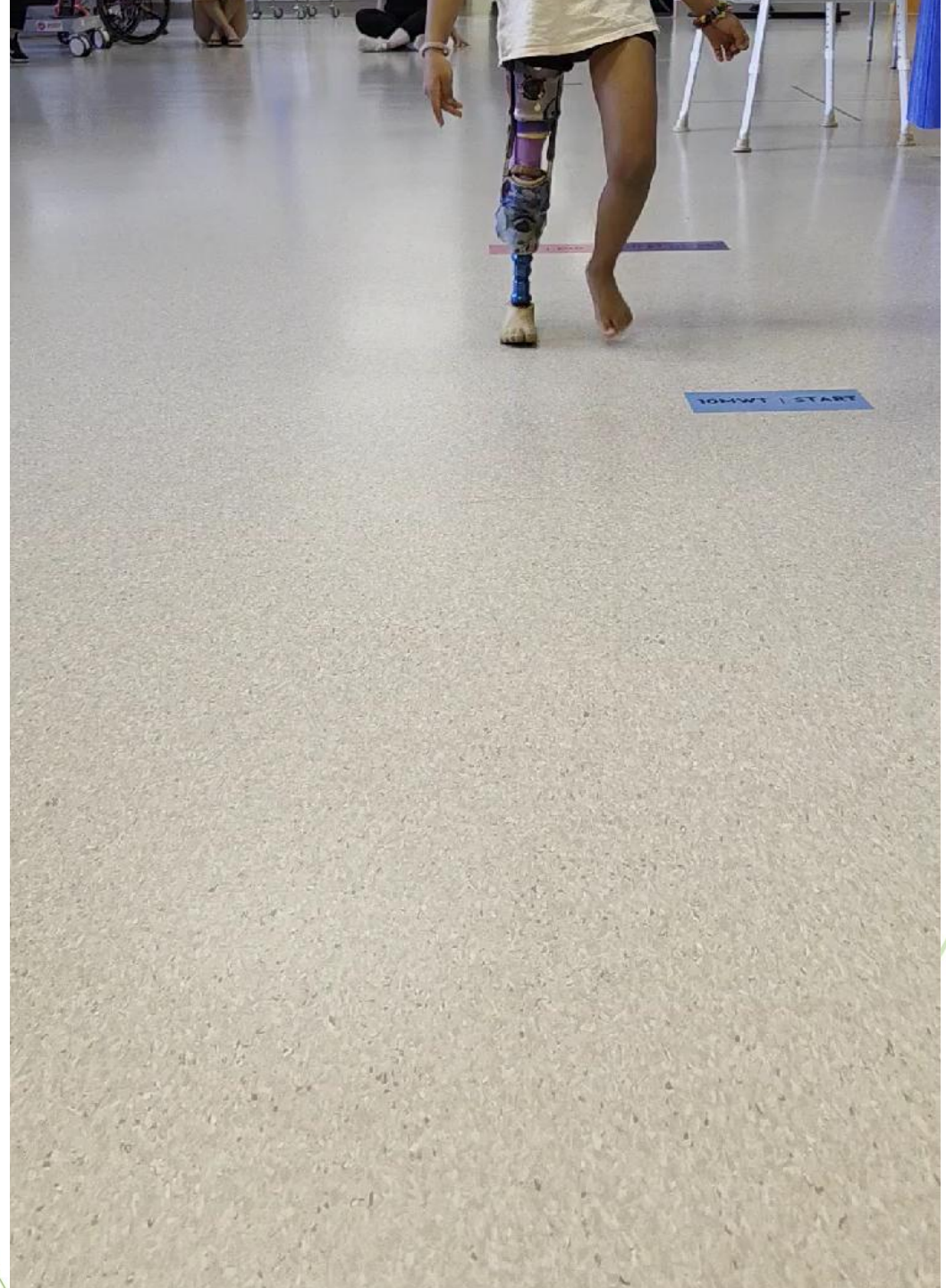
Contracture prevention/ management



The Right Fit – The prosthesis

- Kneekle alignment key
- Alignment and containment of foot for ample clearance of toes
- Trim lines above surgical site and metal work
- Light weight
- Prosthetic foot position can be dependent on available height

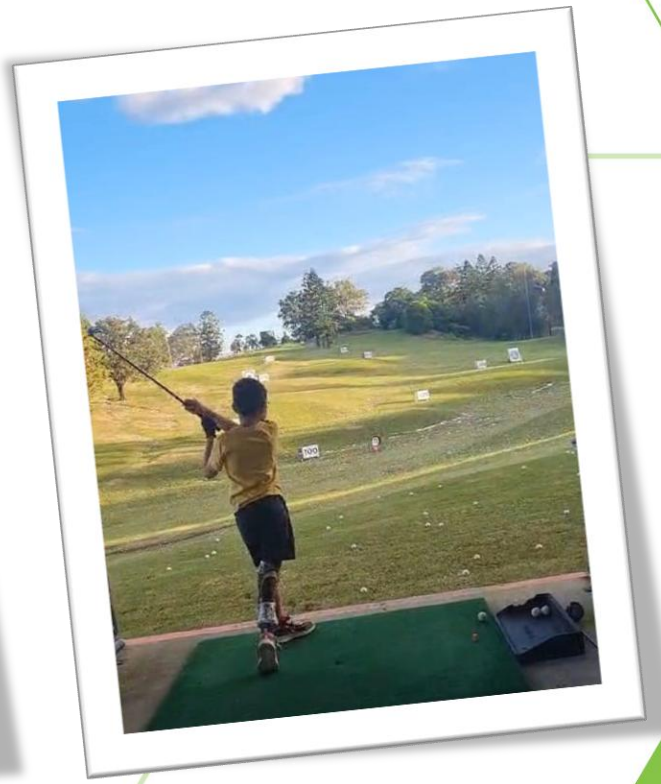
Prosthetic Gait Training



- Find middle again
- Build trust in prosthesis
- Learn to use muscles in a new way!
- Endurance

Functional Outcomes / Return to Life

- Higher Musculoskeletal Tumor Society (MSTS) and Toronto Extremity Salvage Scores (TESS) than patients with alternative limb-sparing procedures or amputations (Ginsberg et al, 2007)
- One study indicated rotationplasty better than transfemoral amputation but inferior to limb salvage (Hopyan et al, 2006)
- 85% of patients with rotationplasty participating in high level sports (Hillmann et al, 2007). Nb limitations on endoprosthetic use.



Emotional

- ‘psychosocial functioning, general quality of life, and social support were comparable to healthy peers’ (SF-36 questionnaire) (Veenstra et al)
- Negative effects on initiating social/intimate contact, body image and sexuality in almost 50% of patients
- ‘rotationplasty patients marry and have children at the same rate as other limb-salvage patients’

Thank you

Any Questions?

BJO

■ ONCOLOGY

Rotationplasty outcomes assessed by gait analysis following resection of lower extremity bone neoplasms

A SYSTEMATIC REVIEW AND META-ANALYSIS

P. Filis,
D. Varvarousis,
G. Ntritsos,
D. Dimopoulos,
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N. Giannakeas,
A. Korompilias,
A. Ploumis

From University of Ioannina, Medical School, Ioannina, Greece

Aims
The standard of surgical treatment for lower limb neoplasms had been characterized by highly interventional techniques, leading to severe kinetic impairment of the patients and incidences of phantom pain. Rotationplasty had arisen as a potent limb salvage treatment option for young cancer patients with lower limb bone tumours, but its impact on the gait through comparative studies still remains unclear several years after the introduction of the procedure. The aim of this study is to assess the effect of rotationplasty on gait parameters measured by gait analysis compared to healthy individuals.

Methods
The MEDLINE, Scopus, and Cochrane databases were systematically searched without time restriction until 10 January 2022 for eligible studies. Gait parameters measured by gait analysis were the outcomes of interest.

Results
Three studies were eligible for analyses. Compared to healthy individuals, rotationplasty significantly decreased gait velocity (-1.45 cm/sec; 95% confidence interval (CI) -1.98 to -0.93; $p < 0.001$), stride length (-1.20 cm; 95% CI -2.31 to -0.09; $p < 0.001$), cadence (-0.83 stride/min; 95% (CI -1.29 to -0.36; $p < 0.001$), and non-significantly increased cycle time (0.54 sec; 95% CI -0.42 to 1.51; $p = 0.184$).

Conclusion
Rotationplasty is a valid option for the management of lower limb bone tumours in young cancer patients. Larger studies, with high patient accrual, refined surgical techniques, and well planned rehabilitation strategies, are required to further improve the reported outcomes of this procedure.

Cite this article: *Bone Jt Open* 2023;4-11:817–824.

Limb Salvage and Outcome of Osteosarcoma: The University of Muenster Experience.

Lindner Norbert J. MD; Ramm, Oliver MD; Hillmann, Axel MD; Roedl, Robert MD; Gosheger, Georg MD; Brinkschmidt, Christian MD; Juergens, Heribert MD; Winkelmann, Winfried MD

Clinical Orthopaedics and Related Research (1976-2007): January 1999

KNEE

Evaluation of postoperative general quality of life for patients with osteosarcoma around the knee joint

Akahane, Tsutomu[a]; Shimizu, Tominaga[a]; Isobe, Ken'ichi[a]; Yoshimura, Yasuo[a]; Fujioka, Fumio[b]; Kato, Hiroyuki[a]

Author Information

Journal of Pediatric Orthopaedics B 16(4):p 269-272, July 2007. | **DOI:** 10.1097/BPB.0b013e3280925670

Pediatric Blood & Cancer

Research Article

A comparative analysis of functional outcomes in adolescents and young adults with lower-extremity bone sarcoma

Jill P. Ginsberg MD, Shesh N. Rai PhD, Claire A. Carlson RN, BSN, Anna T. Meadows MD, Pamela S. Hinds PhD, RN, FAAN, Elena M. Spearing MA, DPT, PT, PCS, Lijun Zhang MS, Lulie Callaway PT, MS, Michael D. Neel MD, Bhaskar N. Rao MD, Victoria G. Marchese PhD, PT

International Journal of Surgery Case Reports 79 (2021) 295–298

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Long-term follow-up of patients with rotationplasty

Ali Mahmoud[a,b], Muhammed Fayez Aboujaib[a,b,*], Muhammad Rafat Meda[a,b]

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[b] Albairouni University Hospital, Damascus, Syria[1]

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ORIGINAL ARTICLE

Sports Activities and Endurance Capacity of Bone Tumor Patients After Rotationplasty

Axel Hillmann, MD, Roger Weist, MD, Albert Fromme, MD, Klaus Völker, MD, Dieter Rosenbaum, PhD

Journal of Surgical Oncology 2012;105:331–336

Living With Rotationplasty—Quality of Life in Rotationplasty Patients From Childhood to Adulthood

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[2] Bologna Hospital-University, Policlinico S. Orsola Malpighi, Bologna, Italy

ORIGINAL ARTICLE

Comparison of Fixation Techniques for Lower Extremity Rotationplasty

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Review article / Artykuł przeglądowy

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Sposób cytowania / Cite Kowalczyk K, Jarząb S. Rotationplasty procedure. *Aesth Cosmetol Med.* 2021;10(2):55-58. https://doi.org./10.52336/acm.2021.10.2.02

Rotationplasty procedure

Zabieg plastyki rotacyjnej

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Sposób cytowania / Cite Kowalczyk K, Jarząb S. Physiotherapy treatment for rotationplasty. *Aesth Cosmetol Med.* 2021;10(3):115-117. https://doi.org./10.52336/acm.2021.10.3.03

Physiotherapy treatment for rotationplasty

Postępowanie fizjoterapeutyczne w plastyce rotacyjnej

ROTATIONPLASTY OF THE LOWER LIMB FOR CONGENITAL DEFECTS OF THE FEMUR

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