Under the leadership of Barb Fitzsimmons and Kishore Mulpuri, an interdisciplinary team has been assembled at BC Children’s Hospital (BCCH) to support the orthopaedic needs of children with cerebral palsy (CP) and similar conditions. The Orthopaedic Cerebral Palsy Clinic has resulted in enhanced surgical planning and management of children with CP. As a result of additional resources, the wait time for hip surgery has been reduced and the complexity of surgeries has decreased.

Since 2009, the Orthopaedic CP team has grown to include 4 orthopaedic surgeons, physiotherapy, occupational therapy, and nursing services. The team aims to provide comprehensive, individualized, family centered treatment for each child. They work diligently to produce educational resources, develop avenues for improved communication with community stakeholders, and maximize the use of expertise and resources to improve access to care. Since 2009, the clinic has been involved in the care of over 650 children and the planning of approximately 330 surgeries.

**IMPACT OF ORTHOPAEDIC TEAM**

- Decreased surgical wait list.
- Improved access to care and surgical intervention, causing a shift in the type of hip surgeries completed, with a reduction in the number of salvage procedures completed (Figure 1).
- Development of educational material, including an Orthopaedic CP Clinic webpage on the BCCH website (www.bcchildren.ca/orthocpclinic)
- Improved access to knowledgeable clinic staff and communication with community stakeholders.
- Improved pre-operative planning has resulted in the identification of equipment, transportation, therapy, and splinting needs prior to inpatient admission, facilitating discharge from the inpatient ward.
- Identification of appropriate therapy services for the post-operative period.
- Advocacy for services for children who do not qualify for publicly funded therapy services or who require more intensive services post-operatively than typically available.
- Improvements in transition to adult services to ensure young adults continue to receive appropriate musculoskeletal follow up.

Figure 1: Proportion of Surgeries for Hip Displacement at BCCH
Rotational Profiles: Correlation Between Computed Tomography and 3D Gait Measures
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Introduction:
Children with cerebral palsy (CP) often require orthopaedic surgery to correct internally or externally rotated limbs that can result from spastic muscles exerting forces on growing bones. Historically these malrotations have been imaged and measured using computed tomography (CT). CT is a static measure and does not describe the dynamic aspects of gait which also need to be considered to ensure optimal functional outcomes after corrective surgery. CT also exposes children to radiation that may not be necessary. In the past the accuracy of rotations measured by clinical gait analysis (CGA) has been questioned [1]. However, advancements in mathematical correction of rotational errors resulting from inconsistent marker placement in CGA have made transverse plane kinematics repeatable and reliable [2]. Because of these improvements, revisiting the importance of using CT for surgical planning should be questioned given that gait analysis can accurately measure the dynamic rotations in gait. The purpose of this study was to determine the association between rotations measured using CT and rotations measured while the child is walking using three-dimensional (3D) gait analysis.

Methods:
Based on an orthopaedic assessment, 30 ambulatory children between ages 5 and 18 years with a diagnosis of CP and rotational abnormalities of the lower limb were recruited for this project. Children were referred to the BC Children’s Hospital Radiology Department for routine CT rotational profile measurements. These measurements were recorded as single values for acetabular anteversion, femoral anteversion and tibial torsion using standard techniques.

Three dimensional CGA was also performed on each child. Using a 12 camera Motion Analysis system (MAC, Santa Rosa, CA), data from a modified Helen Hayes marker set were collected. Kinematic data were calculated using Visual 3D (C-Motion, Rockville, MD) and custom Matlab code to correct for crosstalk between the flexion and varus axes at the knee joint using a routine based on the Baker method [2].

Results:
Femoral anteversion and tibial torsion measured from the CT were compared to peak and mean values of thigh and shank rotations from gait analysis by calculating the interclass correlation coefficients (ICC2,1) [3]. The ICCs are summarized in Table 1. ICC values 0.75 or higher were considered to indicate excellent correlation, 0.40-0.74 fair to good and below 0.39 poor. [4]

Discussion:
Results from this study showed:

• A weak correlation between femoral and tibial rotations between CT and gait measurements.

• Although these correlations are weak, it should be noted that the measurements of rotation in the gait lab are repeatable and measure dynamic malalignments.

• Static measures based on CT are susceptible to patient alignment error and measurement error as was seen with some of our test subjects.

Based on the repeatability of gait analysis and the dynamic nature of the measurement, it is recommended that gait analyses, that use correction for marker placement error, be conducted on children with rotational alignment issues to aid surgical planning.

References:
Celebrating 60 years with the CP Association of BC

The BC Children’s Hospital CP Ortho clinic provides critical medical and rehabilitation services for children living with CP. The Cerebral Palsy Association of BC is proud to be their partner. When first hearing of a diagnosis of cerebral palsy, parents are generally full of questions. Here at the CPABC, we stand ready with information, referral and a wide variety of programming to support people living with CP from initial diagnosis throughout their entire life.

In 1954 a group of parents of children with CP, along with medical and other service providers came together to form a provincial resource to help those living with CP attain the maximum independence possible. CPABC is now affiliated with the international CP United to raise awareness and track research into this condition. One of BC’s longest serving nonprofit associations, CPABC has been the “go to” resource for people living with cerebral palsy and other disabilities for 60 years. To achieve our vision of a life without limits for people with disabilities, our services and programs consist of a wide range of information, public education and awareness, and support and advocacy services based out of our Vancouver headquarters. A website, toll-free information line, quarterly newsletter, and Speakers’ Bureau enable us to reach out across the Province. Our well-known publications, The Guide to CP, Living with CP, and Putting the Puzzle Together, provide much-needed information to the CP community, both in British Columbia and throughout the world. We offer family and individual, our Community Connections Forums provide opportunity for fun, fellowship and

Surgical information at your fingertips! (www.bcchildrens.ca/orthocpclinic)

Orthopaedic interventions are frequently recommended for children with cerebral palsy. Although education is provided during pre-operative visits, the amount of information given is often overwhelming and details are lost or forgotten. Families rely on their community health providers and the internet to help them understand the process. Unfortunately, there is no method to ensure the information available on the internet is trustworthy or accurate.

Lack of information regarding upcoming surgeries and post-operative processes leads to increased frustration in families. Families who receive more knowledge prior to surgery are more positive about upcoming procedures.

The Orthopaedic CP Clinic website has been developed as an educational resource for families and community health providers. It acts as an accessible, efficient teaching tool and provides a reliable source of information for families and therapists to review at their own pace.

This website provides a forum for parents and community therapists to review the details of a surgical intervention including why and how a surgery is performed, how to prepare for surgery, and what to expect after surgery.

The site includes information on the following:

- Cerebral palsy
- Botulinum toxin (Botox®)
- Hip surveillance
- Surgery for hip displacement
- Lower extremity surgery including Single Event Multilevel Surgery (SEMLS)
- Clinic team and contact information
- How to make referrals
- Helpful links
The Canadian Cerebral Palsy Registry

The Cerebral Palsy Registry - BC Division is a part of the Canadian Cerebral Palsy Registry, which is a confidential, non-identifiable, nation-wide collection of medical and social information about children with cerebral palsy (CP). The Registry has a clear definition and specific inclusion and exclusion criteria. The Registry was first implemented in 2003 in Quebec and was later extended to include the provinces of British Columbia, Newfoundland, Nova Scotia, Ontario, and Alberta. Since 2003, more than 1400 children have been registered. Currently there are 18 different CP registers or population data collections on CP in Europe and a register with data collection in Australia. This Registry is the first national registry for cerebral palsy in North America.

The main aim of the Canadian Cerebral Palsy Registry is to provide researchers with the approximate number of children with cerebral palsy across Canada and to show if these numbers are different from province to province. Data in the Registry may help researchers find reasons behind the cause of cerebral palsy, and will also support studies to better understand parents' perspectives on their child's care and how services are provided to them which may lead to improvements in the overall care of children with CP. In addition the Registry is useful to clinicians by enabling them to identify subgroups of children requiring specific etiologic investigations, and also provide more accurate information to the parents of children with CP.

This registry is part of the CP Demonstration Project for NeuroDevNet which brings together an inter-disciplinary team with complementary levels of expertise (clinical research, epidemiology, molecular genetics, advanced imaging techniques, animal models, regenerative medicine, outcomes and health services research) in order to form a collaborative network that works together to increase our understanding of the causes of CP and explore potential avenues for both prevention and treatment.

Our goal is to identify all children in BC, who are diagnosed with cerebral palsy, obtain consent from parents for participation in an interview and to fill out surveys for the purpose of registering the child's information with the Canadian Cerebral Palsy Registry.

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