Reliability of freehand 3D ultrasound for assessment of in vivo triceps surae muscle volume in typically developing infants

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Introduction
Muscle volume is an important architectural parameter linked to the force-generating capacity of a muscle. Infant gastrocnemius and soleus muscle volumes have scarcely been investigated, despite the importance of these muscles in allowing gait and posture maintenance. A key consideration when utilising imaging modalities to assess muscle morphology is reliability. Reliability is vital to ensure that measurements of muscle volume are reproducible and consistent for a given setting. This is especially true given that infant populations possess structurally different muscles from adults. This study aims to assess the intra-acquirer, intra-processor, and inter-processor reliability of freehand 3D ultrasound for the assessment of in vivo medial gastrocnemius (MG), lateral gastrocnemius (LG), and soleus (SOL) muscle volume.

Materials and methods
The MG, LG, and SOL volumes of both limbs in eight 3-month-old infants and nine 6-month-old infants were assessed using a freehand 3D ultrasound system. One researcher carried out the scanning, and two researchers independently processed the acquired scans to estimate muscle volume. All reliability measures were assessed using the intraclass correlation coefficient (ICC).

Results
Intra-acquirer, intra-processor, and inter-processor reliability ICCs were higher than 0.7 for both 3-month-old and 6-month-old participants (ICC range: 0.772–0.980).

Conclusions
The freehand 3D ultrasound system demonstrated good to excellent reliability and repeatability in muscle volume measurements in typically developing infants in vivo. However, future investigations will be required to develop a complete model of typical muscle growth for comparison. Ultimately, 3D ultrasound may be a viable technique for facilitating diagnosis and management of neuromuscular conditions via muscle volume assessment.

Gastric dysrhythmias provoked in healthy subjects correlate with upper gastrointestinal symptoms

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Introduction
Gastric functional disorders are highly prevalent; however, diagnosis and management remain inadequate due to a lack of objective biomarkers. Evaluation of gastric electrophysiology may yield clinically useful biomarkers; however, whether gastric dysrhythmias and symptoms are correlated is yet to be established.

Materials and methods
A combined nicotine/meal stimulus was used to provoke upper gastrointestinal (UGI) symptoms in a group of 10 healthy subjects. Six of these subjects also underwent a non-nicotine control study. Gastric electrophysiology was evaluated using a novel body surface gastric mapping (BSGM) technique, alongside evaluation of UGI symptoms on a 0–10 scale. BSGM data and symptom scores were assessed for correlation.

Results
Nine subjects had symptomatic responses to the stimuli. The most commonly reported symptoms were nausea (median 4/10 severity) and excessive fullness (2/10). After the meal, frequency abnormalities were observed in 7/10 subjects, “uncoupled” (irregular) activity in 7/10, and pattern abnormalities in 5/10. No control arm subjects had symptomatic responses or abnormal gastric electrophysiology. In symptomatic subjects, 7/9 showed a clear correlation between symptom onset and abnormal gastric electrophysiology, encompassing abnormal frequencies, aberrant slow wave propagation direction and uncoupled activity.

Conclusions
A new method of BSGM for measuring gastric electrical abnormalities was validated. The stimulus used was found to induce both symptoms and dysrhythmias, and the results suggest that some UGI symptoms, nausea in particular, have a close relationship with gastric dysrhythmias. In future, this method is likely to find use in the diagnosis of gastric functional disorders.
The pathogenesis of tonsillar hyperplasia in children

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Introduction
The surface area of the human palatine tonsils is extensive, with many folds and crypts. Bacterial microcolonies in tonsillar crypts have been implicated as a target of host inflammatory cells, resulting in chronic inflammation and substantial morbidity in children. Antibiotics are the primary medical treatment for both recurrent tonsillitis (RT) and sleep-disordered breathing (SDB), even though tonsillar microbiology is not well understood. The role of atopy in tonsillar hyperplasia is also largely unknown. We aimed to determine the underlying immunological and microbiological factors that may influence tonsillar hyperplasia in children.

Materials and methods
Paired tonsils were collected from 25 children undergoing tonsillectomy in the Auckland region. Immunohistochemistry and immunofluorescence techniques were used to identify local inflammatory cells and immunoglobulin isotypes. Fluorescence in situ hybridisation techniques were also used to determine the spatial distribution of specific bacterial species within tonsillar microcolonies.

Results
Strong immunoglobulin E (IgE) staining was observed in the tonsillar follicles and was associated with B lymphocytes. Bacteroides spp., Fusobacterium spp., Streptococcus spp., Haemophilus influenzae, and Pseudomonas spp. were all present in tonsillar microcolonies in decreasing quantities. Bacteroides spp., Fusobacterium spp., and Streptococcus spp. were most commonly located around the periphery of the microcolonies, while H. influenzae and Pseudomonas spp. were found nearer the centre.

Conclusions
This is the first study to determine and analyse the spatial arrangement of specific bacterial species within tonsillar microcolonies. These results advance our understanding of the microbiology and immune response of tonsillar hyperplasia and may provide promising avenues for developing effective treatments.

Feasibility and development of a novel diagnostic tool: body surface colonic mapping

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Introduction
Current routine investigations of colonic motility and functional disorders are invasive or require ionising radiation, provide inadequate data on specific motility patterns, and fail to identify symptom-producing abnormalities. Recently, body surface electrical recordings have identified rhythmic colonic activity stimulated by food intake. This has led to a new clinical test called ‘Body Surface Colonic Mapping’ (BSCM). BSCM measures contraction frequency and spatial patterns, allowing high-resolution identification of complex contraction patterns.

Materials and methods
A literature review was completed to evaluate current investigations of colonic motility and functional disorders and their suitability as tools in the clinical environment. A physiological validation study following colonoscopy was undertaken with concurrent, time synchronised High-Resolution Colonic Manometry (HRCM) and non-invasive BSCM tests plus meal challenge. iTK-Snap was used to segment the colon between the upper rectum and splenic flexure in 41 de-identified computed tomography (CT) scans. Segmentation were transcribed to three-dimensional matrices to determine sigmoid colon position.

Results
Time synchronised HRCM and BSCM were conducted in three participants and stand-alone BSCM in one participant. A moderate correlation was identified between the manometry and BSCM methods (Pearson’s correlation r=0.43; P=0.0001). This correlation indicates that the BSCM was reliably detecting the colonic activity, showing proof of concept for BSCM. Significant correlations were found between the positioning of anatomical surface markers and the maximal extent of Left and Right areas of interest.
Conclusions
BSCM is a clinically feasible diagnostic and research tool. It has potential to refine our understanding of, and the diagnostic criteria for, functional colon disorders; provide patients with an explanation for their symptoms; and support biomarker-driven development of innovative therapies. Now that sigmoid colon position has been defined, and a colon-specific electrode array is in development, validation against gold standard HRCM is the next step toward clinical practice.

Myometrial and fetal hepatic oxygen delivery with maternal position: an MRI study
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Introduction
Maternal supine sleep position is an independent risk factor for stillbirth. Alongside reduced placental perfusion, oxygen delivery to the fetus is significantly reduced with the maternal supine position. Fetal adaptation to hypoxia involves increased shunt through the ductus venosus away from the fetal liver, therefore increasing cerebral perfusion and oxygenation. The delivery of oxygen from the maternal myometrium and fetal adaptation to changes in oxygen delivery have not been directly assessed.

Results
In the myometrium, perfusion decreased, but not significantly; however, the small effect was enough to decrease oxygen saturation in the supine position by 3% (p=0.03). This is consistent with aortocaval compression reducing both blood flow and oxygen delivery to the uterus and downstream, and with previous data showing a decrease in placental oxygen saturations in the maternal supine position in the same patients. Neither perfusion nor diffusivity of the fetal liver changed significantly, nor did oxygen saturation, which may point to the operation of hypoxic compensatory mechanisms.

Conclusions
Our results are the first to quantify the myometrial and fetal effects of position change, and are consistent with the concept of the oxygen margin of safety of the healthy fetus so that it may tolerate hypoxic stresses.

Exploring the role of dexamethasone on glioblastoma invasion
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Introduction
Glioblastoma (GBM) is an extremely malignant brain tumour with a median survival of 14.6 months. This is attributed to the increased invasiveness of a subpopulation of cells known as the glioblastoma cancer stem cells (gCSCs). Recently, dexamethasone (Dex), has been shown to reduce migration and further invasion of GBM. The interactions Dex has on these cells is unknown.

Materials and methods
The Cell Invasion and Migration (CIM) and sphere migration assay were used to measure the effects of Dex on NZB11 gCSC invasion. Flow cytometry and cyometric bead arrays were used to quantify the associated changes in invasion-related integrin, chemokine, and chemokine receptor expression.

Results
Dex treatment reduced invasion of NZB11 gCSCs by 77% (p=0.0627), 65% (p=0.0012), and 37% (p=0.0213) at 24hrs, 48hrs, and 72hrs respectively. Furthermore, Dex-treated gCSC spheres had a 41% reduction of migration (p=0.002) over laminin, when compared to the control, over the first 24hrs. Dex-treatment resulted in no changes to chemokine receptor expression, but increased integrin α3 expression by 23% (p=0.0392) and decreased integrin αv and β8 expression by 41% (p=0.0015) and 66% (p=0.0002) respectively.

Conclusion
These findings demonstrate that Dex treatment leads to reduced migration and invasion of gCSCs, with associated modulation of the integrins α3 and αvβ8.

Improving the lives of hydrocephalus patients – a novel brain implant
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Introduction
Hydrocephalus is a life-threatening neurological condition. It involves an excessive accumulation of cerebrospinal fluid (CSF) within the cranial vault, and consequently, an increase in intracranial pressure (ICP). The gold standard management involves CSF drainage via a ventriculoperitoneal shunt (VPS). Within the first two years, 50% of VPS fail, and the signs and symptoms that follow are mimicked by common benign illnesses such as gastroenteritis or simple headaches. Thus, 70% of patients presenting with suspected VPS failure are false positives. To improve the accuracy of diagnosing shunt failure, a novel pressure sensor that will be fully implantable within the brain is being developed. The objectives of this project were to: i) carry out a preliminary risk analysis on the current design of the implant; and ii) in light of the device’s non-tethered feature, assess the risk of the intraparenchymal implant displacing over time.

Materials and methods
An internationally-recognised standard for medical device risk management (ISO 14971) was implemented to guide the risk analysis. To assess the risk of implant migration, ten sheep underwent neurosurgery to insert two non-working implants, one in each cerebral hemisphere; and two small screws to the skull, one near each implant (20 implants). X-ray scans were taken postoperatively and three months later, and the screws were used as reference points to measure implant displacement.
The non-tethering element of the implant design was identified as a potential critical risk and accordingly warranted further investigation. Following the in-vivo sheep study, the average absolute displacements of the 20 implants were 1.2 mm +/- 0.2 mm (horizontal) and 1.6 mm +/- 0.3 mm (vertical), relative to the two reference screws.

Conclusion
The findings indicate minimal displacement of the implants three months post-insertion. This suggests that the risk of inserting the implant without an anchor attachment to another anatomical structure is low. However, the study is ongoing, and a six-month follow-up scan, along with histological analysis of the brain tissue, will provide critical information on the long-term risk of the implant migrating. Before clinical translation, further studies to validate the safety of the implant will be required.

Management of severe or recurrent neonatal hypoglycaemia

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Introduction
Neonatal hypoglycaemia is a common and preventable cause of brain injury in infants. New, physiologically-targeted approaches are needed in newborns resistant to first-line management for hypoglycaemia to improve glucose stability, decrease interventions, and promote breastfeeding. Diazoxide is one such potential adjunctive therapy. The primary objective of this thesis was to determine the efficacy and safety of oral diazoxide for the treatment of neonates with severe or recurrent transitional hypoglycaemia in the first week after birth. A secondary objective was to determine the predictive value of continuous glucose monitoring (CGM) trend alarms for detection of blood glucose concentrations (BGC) outside the target range.

Materials and methods
Preliminary evidence for the use of diazoxide in transitional neonatal hypoglycaemia was obtained from a systematic review of the literature and a case series. These data informed the development and implementation of a phase IIB, placebo-controlled, randomised, two-arm, parallel trial of early oral diazoxide for treatment of severe or recurrent neonatal hypoglycaemia, the NeoGluCO Study (I). This included validation of the placebo and physiochemical testing of the active intervention. A real-time Guardian 3 CGM sensor (Medtronic) was inserted on the lateral thigh at enrolment.

Results
Evidence of low certainty, from one randomised controlled trial, suggests that early use of diazoxide therapy in late preterm and term infants admitted with transitional neonatal hypoglycaemia may reduce the duration of intravenous fluid therapy and time to full enteral feeding by two days. In transitional hypoglycaemia, use of lower doses of diazoxide appears to be effective in achieving euglycaemia while avoiding hyperglycaemia. Suspension of diazoxide capsules in Ora Blend SF (10 mg/mL) provides a physiochemically stable intervention for at least 35 days. Ora Blend SF combined with a small amount of corn-starch is an effective placebo, with similar sensory characteristics to the active intervention.

Conclusion
The NeoGluCO Study (I) will determine if early use of oral diazoxide for severe or recurrent transitional hypoglycaemia promotes successful metabolic transition by decreasing the time to establish enteral bolus feeding and normal BGC without intravenous fluids.


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Introduction
It is unknown what portion of decreasing stroke mortality trends in New Zealand are a result of decreasing trends in incidence or improvements in management and case fatality. This study aims to describe the 28-day and one-year case fatality in New Zealanders hospitalised with acute stroke, to describe management post-discharge, and to identify features associated with disparities in these outcomes.

Materials and methods
Using individual patient linkage across national datasets, New Zealand residents aged 25 or older hospitalised with stroke (excluding subarachnoid haemorrhage) between 2014 to 2016 were included. Deaths from any cause within 28 days and between 29 to 365 days following admission to hospital were used to calculate 28-day and one-year case fatality, respectively. Dispensing of antithrombotic medications, statins, and antihypertensive medications at 3 months, 6 months and 12 months post-stroke were used to calculate the proportions of patients with stroke appropriately treated in the community. Analyses were completed in age-stratified groups by prior history of stroke, sex, socioeconomic deprivation, and ethnicity. Multivariable logistic regression models adjusting for demographic features and comorbidities were used to determine the effect of these factors on case fatality at 28 days and one year post-stroke.

Results
A total of 22,547 people were included. After adjustment for demographic features and comorbidities, older age, female sex, intracerebral haemorrhage (OR 5.8, 95% CI: 5.2 to 6.5), unspecified stroke (OR 1.6, 95% CI: 1.3 to 1.8) and recurrent stroke (OR 1.3, 95% CI: 1.1 to 1.4) were associated with increased 28-day case fatality. Only older age was associated with increased one-year case fatality. Compared to people aged ≥75 years old, fewer people aged 25 to 64 years old were dispensed antithrombotic and antihypertensive medications, while fewer women and people aged ≥85 years old were dispensed statins compared to people aged 25 to 64 years old. Indians aged 25 to 64 years old were less likely than Europeans of the same age to be dispensed any of the three medication classes. Māori aged 25 to 74 years old were dispensed more antihypertensives and statins than Europeans of the same age.

Conclusion
This study found substantial differences by various demographic features in 28-day case fatality, one-year case fatality, and medical management. Further research to understand the cause of these disparities is required.
A novel technique for the non-invasive measurement of the cerebral metabolic rate of oxygen (CMRO\textsubscript{2}) in a preclinical model

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Introduction

The brain is almost entirely dependent on oxidative metabolism. Changes in cerebral metabolic rate of oxygen (CMRO\textsubscript{2}) occur in many neurological diseases, but often require invasive procedures to measure accurately. The aim of this study was to develop and validate a novel method to assess whole brain CMRO\textsubscript{2} in a rat model.

Materials and methods

CMRO\textsubscript{2} was assessed in anaesthetised Wistar rats (n=19, 270–396g) during randomised changes in inspired oxygen (21, 30, 40, 70 and 100% O\textsubscript{2}). A perivascular probe was used to measure internal carotid flow. Non-invasive measures of oxygen saturation (SO\textsubscript{2}) in the superior sagittal sinus (venous) and arterial circulation (pulse oximeter) were validated against direct measures of SO\textsubscript{2} in blood samples taken from the abdominal aorta and just distal to the retroglenal vein, which drains the cerebral sinuses.

Results

There was no significant difference between venous SO\textsubscript{2} from photoacoustic imaging versus direct blood samples (mean absolute difference 8.60 ± 8.33% Hb, p=0.010). CMRO\textsubscript{2} (2.13 ± 0.70 μmol·g\textsuperscript{−1}·min\textsuperscript{−1} by blood test results versus 2.79 ± 1.28 μmol·g\textsuperscript{−1}·min\textsuperscript{−1} by novel method, p=0.02) was preserved across profound changes in arterial (43–100%) and venous (31–96%) SO\textsubscript{2}. Bland-Altman analyses revealed a high degree of agreement between invasive and non-invasive measures of SO\textsubscript{2} and CMRO\textsubscript{2}.

Conclusion

Our results confirm that our photoacoustic measure of venous SO\textsubscript{2} is comparable to the ‘gold-standard’ method using direct blood sampling. Thus, our non-invasive approach to measuring CMRO\textsubscript{2} appears to be viable.

Topical tranexamic acid in endoscopic sinus surgery

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Introduction

Bleeding after Endoscopic sinus surgery (ESS) is unpleasant for patients and generates significant costs. Tranexamic acid (TXA) is an inexpensive and widely used medication for the reduction of bleeding. Currently, the practice of the senior author is to use both topical and intravenous (IV) TXA during ESS to minimise bleeding. However, little is known about the safety and efficacy of this policy.

Materials and methods

To investigate this, three studies were conducted. First, a scoping review was used to investigate the effect of TXA on respiratory mucosa. A retrospective single-surgeon study was used to assess all comprehensive ESS cases at Waikato Hospital from January 2017–December 2019 for the safety and efficacy of combined IV and topical TXA. A randomised controlled trial (RCT) is being conducted to evaluate the immediate post-operative use of topical TXA with regards to bleeding and healing.

Results

Evidence from the scoping review suggests that TXA has no detrimental morphological or cytological effects on respiratory mucosa and may have a positive effect on healing. The retrospective study suggests that using both topical and IV TXA in ESS is safe and effective at minimising post-operative bleeding and scar formation. The randomised controlled trial is still ongoing, and to date, we have randomised 30 patients.

Conclusions

In this thesis we explore the use of topical TXA in ESS. There is evidence that topical TXA may be an ideal and low-risk wound dressing. We anticipate that the RCT will provide more evidence to support its use.

The effect of maternal consumption of oxidised fish oils on offspring skeletal development

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Introduction

Fish oils are rich in omega-3 polyunsaturated fatty acids (n-3 PUFAs) and are commonly consumed during pregnancy. N-3 PUFAs readily degrade into oxidised lipids, and exposure to oxidised lipids results in oxidative stress and potential growth retardation. This study examined the effect of maternal consumption of varying doses of oxidised lipids on femur length and growth plate development in male offspring at postnatal day 21. We hypothesised that maternal consumption of oxidised fish oil would lead to shorter femur length, abnormal growth plate organisation, and reduced hypertrophic chondrocyte cell area in the offspring.

Materials and methods

Five groups of Sprague-Dawley dams (n=42) were fed gels containing oxidised fish oils at known doses: a control group which received no fish oil, three groups fed 0.05mL of oxidised fish oil with peroxide values of 5, 10, and 40, and one group fed 1mL of oxidised fish oil of peroxide value 40. At postnatal day 21, offspring were weighed and culled, the femora and tibiae were removed and fixed. Femur length was measured using digital callipers, and proximal tibiae were processed for histology. Growth plate zone heights were measured from toluidine-stained sections of each tibia (n=5 per treatment group), and the cell area of hypertrophic chondrocytes was measured using haematoxylin and eosin Y-stained sections (n=4 per treatment group), and values were expressed as a mean and standard error of the mean (SEM).

Results

At post-natal day 2 there was significantly high mortality within PV40 and PV40\textsuperscript{4} offspring. At day 0, nose-to-anus length was shorter in PV40\textsuperscript{4} offspring compared to control offspring. At post-natal day 21, femur length was longer in PV40 and PV40\textsuperscript{4} male offspring compared to control offspring. Growth plate zone heights and ratios remained constant across treatment groups, and cell area of hypertrophic chondrocytes was constant as well.
Conclusions

The finding that femur length was longer in the highly oxidised fish oil treatment groups was contrary to the hypothesis of the study. As the growth plate zone heights, ratios, and cell area remained constant, differences in the organisation of the growth plate were not the cause of greater femur length. The longer femur length implies a period of more rapid skeletal growth, but this was not measured. Potential mechanisms for greater femur length include: 1) a survivorship bias, if in the groups with high mortality, death was non-random and animals that would have had smaller femurs were more likely to die; and 2) a biomimetic growth-accelerating effect of oxidation products such as isoprostanes, which are suspected to have been present at high concentration in the oxidised fish oil. Despite the apparent growth-enhancing effect of oxidised fish oil, its use should not be encouraged during pregnancy, as it increased newborn mortality, and the effects on the adult offspring were not determined. Further research should include female offspring, and analysis at different time points such as GD20, PN2, and PN100.

The predictors of compassion in medical students: a systematic review and preliminary study of the origins of care in our future doctors

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Introduction

Despite being a mandated, foundational value in healthcare, compassion remains poorly researched. Existing work has contributed little towards the understanding of the origins of compassion, or identifying potential targets and avenues for compassion-enhancing interventions. In contributing to this area of work, the current thesis builds on studies in empathy—a related, but distinct construct with a stronger empirical base—to investigate a) the factors associated with compassion in medical students, and b) whether the factors that influence compassion vary across the course of medical training.

Materials and methods

Two studies, both based within the Transactional Model of Physician Compassion ("Transactional Model"), were conducted. In the first study, a systematic review identified studies assessing factors associated with compassion among medical students. Studies were synthesised within the four-domain framework of the Transactional Model. In the second study, data from an existing dataset on the barriers to compassion were analysed. Three-hundred and fifty-one New Zealand medical students in their clinical years (Years 4–6) completed questionnaires, and the effects on the adult offspring were not determined. Further research should include female offspring, and analysis at different time points such as GD20, PN2, and PN100.

Materials and methods

Two studies, both based within the Transactional Model of Physician Compassion ("Transactional Model"), were conducted. In the first study, a systematic review identified studies assessing factors associated with compassion among medical students. Studies were synthesised within the four-domain framework of the Transactional Model. In the second study, data from an existing dataset on the barriers to compassion were analysed. Three-hundred and fifty-one New Zealand medical students in their clinical years (Years 4–6) completed questionnaires, and the effects on the adult offspring were not determined. Further research should include female offspring, and analysis at different time points such as GD20, PN2, and PN100.

Results

The review found that among the limited empirical work to date, the majority of studies have focused on the student-related factors associated with compassion. This focus has not only neglected three key areas of influence on compassion, but has also limited the study of factors to those that are generally “fixed” and therefore not amenable to intervention. In the second study, analyses indicated that Year 6 students reported higher student-related, patient-related, and environmental (but not clinical) barriers to compassion than Year 4 students; the degree of difference was comparable across the three barriers. Hierarchical regression confirmed that year level predicted barriers to compassion and showed that greater self-compassion consistently predicted lower barriers.

Conclusions

The combination of review and empirical work in this thesis suggests that current research on compassion in medical students remains limited in quantity, quality, and scope. A more multifactorial approach is needed in future studies to provide a fuller understanding of the influences on compassion in medical students and identify targets better suited to intervention. Given that the barriers to compassion vary in a way that suggests students find it harder to care for patients as they progress through training, the opportunity for intervention is clear. Directions for future research are discussed.

The reliability and measurement of muscle volume of the knee extensor muscle using magnetic resonance imaging in infants

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Introduction

Muscle growth through childhood is believed to impact further growth and development of an individual across the lifespan; however, very little is currently known about early muscle development through infancy—the most rapid period of growth. The aims of this study were to: i) establish reliability for the measurement of infant thigh muscle volume (MV) using magnetic resonance imaging (MRI) and ii) establish normative values for knee extensor MV in infants under the age of 6 months.

Materials and methods

A total of 24 typically-developing infants aged 0–6 months were recruited. Axial spin-echo T1-weighted proton density sequence MRI scanning took place in a 3T whole-body MR. Post-imaging analysis was conducted in 3D Slicer Medical Imaging software by two independent raters to assess and compare knee extensor MV by slice-by-slice manual segmentation. Scans were repeated by raters to establish levels of inter-rater and intra-rater reliability.

Results

Inter-rater reliability for all knee extensor muscles was excellent (Intraclass correlation coefficient (ICC)=0.974-0.960, n=15 limbs). Intra-rater reliability was excellent (ICC=0.901-0.972) for the four knee extensor muscles (n=10 limbs), with vastus intermedius having the lowest reliability (ICC=0.901). Of 24 infants (median age 76 days (38.6 days), range 6–174 days), the MV for each part of the knee extensor muscles were as follows (mean ± SD): rectus femoris 6.2 ± 1.7 cm3, vastus medialis 9.6 ± 2.5 cm3, vastus lateralis 20.7 ± 4.6 cm3, vastus intermedius 4.8 ± 1.1 cm3.

Conclusions

Quantification of knee extensor MV in 0–6 month old infants by manual segmentation is a reliable method of assessing infant muscle growth. Care needs to be taken with defining volumes of the vasti, as the indistinct borders and variable morphology make manual segmentation difficult to conduct, introducing variability in measurement. Inter-individual variability as large as 24.5 cm3 in the MV of one limb is evident from as young as 3 months of age.