Reproductive Ultrasound Fellowship

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<th>Name of Institution:</th>
<th>McGill University</th>
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<td>Location:</td>
<td>Royal Victoria Hospital</td>
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<td>Type of Fellowship:</td>
<td>Fellowship in Reproductive Ultrasound</td>
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**Program Information:**
- Attached
- Number of fellowship positions requested: ±1 per year
- Duration of fellowship: Two years
- Academic affiliation: McGill University approved
- Name of hospitals involved in training: 1 (Royal Victoria Hospital)

Outline how intended fellowship will enhance residency training:
At present the teaching in Gynecology Ultrasound is sparse and haphazard mainly due to limited interaction and time available for the attending staff to teach. Gynecology ultrasound teaching is perceived as a luxury rather than need. Introduction of a fellowship will reveal the immense usefulness of this modality of investigation and intervention and the need for research in this field. The fellow will be taught systematically and will be an excellent resource to teach the residents. It will not affect the residency training and in fact augment their training as currently there is very little emphasis on teaching gynecology ultrasound.

**Name of the Fellowship Program Director:** Seang Lin Tan – Professor and Director of McGill Reproductive Center, Reproductive Endocrinologist and Infertility Specialist

**Names of the Teaching Faculty**
- Srinivasan Krishnamurthy – Senior training faculty, General and Reproductive Gynecologist and Director of reproductive ultrasound
- William Buckett – Associate Professor and Staff, McGill Reproductive Center, General and Reproductive Gynecologist
- Hananel Holzer – Assistant Professor and Staff, McGill Reproductive Center, General and Reproductive Gynecologist
- Michael Dahan - Assistant Professor and Staff, McGill Reproductive Center, General and Reproductive Gynecologist
- Ezgi Demirtas - Assistant Professor and Staff, McGill Reproductive Center, General and Reproductive Gynecologist
- Patricia Monnier - Assistant Professor and Staff, McGill Reproductive Center, General and Reproductive Gynecologist
- Richard Brown - Assistant Professor and Staff, Royal Victoria Hospital, General Gynecologist and Director of Obstetric Ultrasound
- Alex Hartmann – Director of True North Imaging, Toronto, fully accredited Radiologist

**Summary of clinical practice and major strengths:**
The above staff have a wealth of both tertiary care general gynecology and reproductive gynecology practice. Referred patients for specialized services are treated by the physicians. REI specialists perform screening ultrasounds, monitoring as well as invasive ultrasounds (oocyte collection for IVF, drainage of ovarian cysts and saline hysterosonograms). Color Doppler ultrasound is commonly utilized to assess the utero-ovarian flow and there is ample opportunity to carry out research in this area.
** Academic Facilities

**Library access, materials relevant to fellowship training:** Women’s pavilion is well stocked with good quality ultrasound books and journals. Multimedia learning materials are available in the library.

**Fellow Duties and Responsibilities**

**Call responsibilities to cover service:**
Home call according to the FMRQ collective agreement will be instituted and the fellow will be the senior supervisor of residents for training and education with regard to gynecology ultrasound according to the Royal College objectives of their training appropriate for their level. This role will clearly be instituted once the fellow’s competency is assessed both by objective and subjective means by the trainers collectively.

**Outline whether there are fixed rotations at various institutions:**
Fellow (s) will be based at Royal Victoria Hospital.

**Outpatient clinic responsibilities need to be outlined:**
Rotational duties will be put in place and the fellow will rotate either longitudinally or vertically as deemed appropriate to obtain maximum clinical content benefit.

**Outline role of the fellow towards residents on service:**

*Teaching responsibilities towards residents:* in gynecology clinics when the fellow is present to train the residents in basic and advanced endovaginal and abdominal ultrasound according to the level of the residents’ training.

*Outline participation in academic activities involving the residents:* The fellow will take an active part in residents’ formal protected teaching and will be expected to participate in the Gynecology, REI and Gynecological oncology outcome assessment (morbidity and mortality rounds etc).

Describe any support staff available to the fellow: program coordinator, nurse clinician, secretarial

**Proposed meetings to be attended by the fellow:**
The fellow will be expected to conduct qualitative and quantitative scientific research and present the study in international meetings such as ISUOG, FIGO meetings and National meetings such as SOGC and ASRM annual meetings.
FELLOWSHIP PROGRAM IN REPRODUCTIVE ULTRASOUND

EDUCATIONAL OBJECTIVES:

Ultrasound has been successfully introduced into the practice of reproductive medicine. Ultrasound imaging plays an important role in the diagnosis and management of the disorders of the female reproductive system. Its use is ever growing in parallel to advancements in the ultrasound technology and our understanding.

The overall aim of this program is to provide the trainee with an understanding of the indications of an ultrasound examination, ability to perform a pelvic scan safely and competently and to report the findings in the clinical context of reproductive medicine.

These tasks require the trainee to:

1. Take a focused clinical history
2. Carry out ultrasound examination in the appropriate environment with respect to the patients’ privacy, cultural and religious needs.
3. Select the equipment which is appropriate for the examination and to optimize its settings
4. Conduct the examination effectively in a gentle and considerate manner
5. Understand the normal morphologic ultrasound appearances of the female pelvis and its variations.
6. Diagnose common gynecological abnormalities and to interpret ultrasound findings in the context of patient’s clinical history and symptoms.
7. Effective assessment of women with reproductive disorders
8. Effective monitoring of women undergoing assisted reproduction treatments
9. Understand the limits of their competence and the need to seek advice where appropriate
10. Write a structured report

It is important that the trainee develops a good knowledge of both reproductive medicine and ultrasound technology.

Eligibility: The applicant should have completed higher specialist training in general obstetrics and gynecology and may have completed a full fellowship in reproductive or maternal-fetal medicine of an approved body such as Canadian Royal College, RCOG (UK) or other recognized international universities.

Duration: 18 months fellowship including a mandatory 4 months research component (apart from the half day each week for research). This will include one to two months rotation at TrueNorth Imaging in Toronto for concentrated training in Sono-hysterograms and initial collection of data for research (for details see appendix 1)
TRAINING PROGRAM SYLLABUS

1. ULTRASOUND TECHNOLOGY

1. Physics and bio-effects of ultrasound
   a. Physical properties of ultrasound and its interaction with tissues
      • wave motion and types of waves
      • wave length, frequency, period, phase
      • intensity, pressure, amplitude
      • decibel notation - intensity and amplitude
      • velocity of ultrasound in liquids and biological media
      • acoustic impedance
      • reflection, reflection co-efficient, critical angle, refraction
      • oblique and normal incidence
      • reverberation, interference, diffraction resonance
      • source of echoes - specular, scattered
      • attenuation, absorption
      • shadowing, enhancement

   b. Biological effects of ultrasound
      • mechanisms: thermal effects, cavitation, streaming
      • measurement of power output and intensity: average power, spatial peak, temporal peak, peak intensity
      • effects on macromolecules, cells
      • genetic and chromosomal effects
      • results of experiments in vitro, studies in other species and human studies
      • effect on germ cells of mother and fetus
      • recommendations on diagnostic ultrasound, ASUM statement, AIUM statement, methods of measurements of power levels
      • power levels used in current equipment
      • methods of dose reduction: equipment design and operation, examination technique

   c. Artefacts in Imaging
      Artefacts due to:
      • axial resolution
      • multiple reflection: axial, non axial refraction
      • attenuation, shadowing, enhancement
      • beam width
      • non uniform velocity
      • side lobe
      • electronic noise
      • instrumentation artefacts, misalignment, signal processing artefacts
      • operational artefacts, scanning techniques, equipment settings

   d. Transducers
      • piezoelectric effect
      • design and construction of transducers
      • transducer resonance
      • pulsed operation, pulse shape and length, frequency spectrum
• beam pattern, plane transducer, near and far field
• beam width calculations
• focusing of transducers
  • focus by lens
  • focus by mirror
  • focus by curved transducer
  • focus by electronic focus (linear array)
  • focus by electronic focus (annular array)
  • meaning of strong, medium and weak focus
• variation of axial intensity with focused transducer
• variation of lateral intensity
• phased array transducers, transmit focus, receive focus

E. Pulse-echo imaging and signal processing
• pulse echo imaging
  • A-mode basic block diagram
  • B-mode basic block diagram
  • M-mode
  • grey-scale imaging
  • dynamic range
  • simple and compound scanning
  • contact and water bath scanning
• special types of scanners
  - rectal and vaginal probes
  - small parts scanners
  - biopsy probes
  - intraoperative probes
• resolution, axial, lateral
• basic pulse-echo instrumentation
• receiver block diagram
• TGC amplifier
• compression amplifier
• controls
  - intensity control (attenuator)
  - gain control
  - time-gain compensation
  - suppression
• registration system
• digital processing
  - digital scan converter (details of analogue scan converter not required)
  - digital signal processing
• pre-processing
• post-processing
• television display and recording
• real-time systems
• basic principles
• mechanical scanners
• linear arrays
• trapezoidal and convex scanners
• phased arrays
• annular arrays

F. Measurement
• linear, area and volume
• limitations, interobserver and intraobserver
• equipment limitations
• use of tissue phantoms
• performance tests and quality control
• performance test principles
  - sensitivity and signal-to-noise tests
  - tissue-equivalent phantoms

g. Image Recording and Storing
• silver photographic plate
• video tape
• heat sensitive paper
• laser disc

h. Scanning Techniques
• percutaneous
• transvaginal
• transrectal
• intra-operative
• advantages and disadvantages of scanning techniques applied to gynecology and reproductive medicine
• protective barriers for endoscanning techniques
• disinfection and sterilization of transducers

i. Doppler Systems
• Doppler effect - derivation of basic Doppler equation
• continuous wave instrumentation, block diagrams
• pulsed Doppler instruments, basic principles
• limitation of velocity measurement, range ambiguity
• spectral analysis
• display and recording of Doppler signals
• color flow mapping of Doppler signals
• power Doppler

j. Tissue Harmonic Imaging

Skills:

The fellow should be able to:
1. Understand the principles of conducting a safe and appropriate ultrasound examination
2. Use an ultrasound machine competently and independently
3. Record scan findings clearly and accurately
4. Keep appropriate hard copy or video records of examination

Teaching and practical module (1):
• One to one instruction
• Teaching session (4 hours) of the theory and demonstration of the available equipment

3. REPRODUCTIVE SYSTEM

The trainee must have in depth knowledge of the human reproductive system, including embryology, anatomy, histology, physiology and functions of the reproductive system.

1. Embryology of reproductive system
   a. Normal development
   b. Congenital anomalies and developmental disorders of the reproductive system.
2. Reproductive system in the prepubertal period
3. Puberty and adolescence
4. The menstrual cycle and folliculogenesis
5. Human reproduction
6. Menopause
7. Post Menopausal period

Skills:

The fellow should be able to evaluate reproductive system with ultrasound:

uterus

1. Size, shape and orientation
2. The endometrium with regard to thickness, length, focal abnormalities, the presence of fluid or masses in the endometrial cavity
3. Cyclical endometrial changes during the menstrual cycle and responses to contraceptive pills and other hormonal preparations

Fellow should become competent in diagnosing congenital and acquired anomalies of the uterus that may affect reproductive functions *by means of 3D ultrasound and sonohysterogram*

Ovaries

1. Localization of ovaries with reference to other pelvic structures
2. Ovarian dimensions and volume.
3. Functional changes in the ovaries during menstrual cycle, follicular appearances, variation in the morphology of corpora lutea, functional cysts, fluid in pouch of Douglas
4. Assessment of ovarian reserve

Adnexa

1. Identification of dilated tubular structures
2. Differentiation of masses of ovarian and paraovarian origin
3. Documentation of characteristics of adnexal masses (cystic, solid, complex)
4. Identification of signs of pelvic inflammatory disease

Teaching and practical module (2):

- Ultrasound sessions – general gynecology (4 per week)
- Log of all ultrasounds performed
- Documented discussion of the normal and abnormal (2 hours per week)

4. GENERAL INFERTILITY

The trainee should have a sufficient understanding of the pathophysiology of infertility. He/She should have sufficient knowledge to take a history and perform a physical and ultrasound
examination relevant to infertility and identify deviations from normal. He/she should have the ability to evaluate disorders and make a diagnosis.

Fellows should:

1. Have the knowledge of infertility in general, etiologies and management of infertile couples.
2. Be familiar with the diagnostic testing of infertile patients, their indications, and contraindications, their limitations, sources of errors and interpretation.
3. Know the different types of ovulation inducing agents, their mechanisms of actions including the doses and regimens of usage and patient monitoring.
4. Fellow should have knowledge of effects of acquired uterine and adnexal pathologies on fertility and outcome of infertility treatments.
5. Know the indications for sonohysterography, hysteroscopy, laparoscopy, in vitro fertilization and other assisted reproductive technologies.

Skills:

Fellows should be able to:

1. Recognize and measure fibroids and polyps, to determine the position of fibroids in relation to uterine cavity.
2. Perform and to interpret the results of a sonohysterography and assess the role of sono contrast hysterogram.
3. Distinguish between different types of ovarian cysts, have a clear understanding of the appearance of endometriotic cysts and to determine their positions in the pelvis.
4. Recognize hydrosalpinges.
5. Perform folliculometry and manage ovulation induction and superovulation cycles.
6. Perform ultrasound guided cyst drainage and biopsy of lesions

Teaching and practical module (3):

- Ultrasound sessions – Infertility clinics (2 per week)
- Log of all ultrasounds performed
- Documented discussion of the normal and abnormal (1 hour per week)

5. ASSISTED REPRODUCTIVE TECHNOLOGIES

The fellows will encounter a wide variety of assisted reproductive technologies.

Fellows should:

1. Obtain a basic knowledge of oogenesis, spermatogenesis, and embryogenesis.
2. Have a clear understanding of different techniques of assisted conception, their indications and limitations.
3. Be familiar with different controlled ovarian hyperstimulation protocols. They should be able to determine protocols for poor responders and patients with polycystic ovarian syndrome.
4. Be able to decide the proper management including dosages and hormonal treatment.
5. Be able to discuss genetic testing required prior to assisted conception and to suggest appropriate treatments.
6. Have an understanding of factors influencing the results of assisted reproduction treatments.
7. Become proficient in monitoring of assisted reproduction treatment cycles with special emphasis on the technique of accurate measurement of multiple follicles.
8. Become familiar with assisted reproduction treatment procedures

Skills:

Fellows should be able to:

1. Effectively perform and interpret scans for monitoring of controlled ovarian hyperstimulation cycles
2. Manage controlled ovarian hyperstimulation cycles with regard to dose adjustments and triggering final oocyte maturation
3. Perform aspiration of ovarian cysts before a treatment cycle
4. Perform follicular aspiration for oocyte collection
5. Guide embryo transfer procedure with transabdominal ultrasound

Teaching and practical module (4):

- Ultrasound sessions – Infertility monitoring sessions (4 per week)
- Log of all ultrasounds performed
- Documented discussion of the normal and abnormal (1 hours per week)

6. EARLY PREGNANCY

The fellow will be conducting first trimester scans following achievement of a pregnancy.

Fellows should:

1. Understand the morphological features of normal early pregnancy
2. Know principles of first trimester biometry and early dating scan
3. Understand physiology of cardiac activity in the first trimester
4. Have knowledge of etiology and incidence of multiple pregnancies
5. Understand the etiology and pathophysiology of early pregnancy loss
6. Have knowledge of ectopic pregnancy
7. Have knowledge of gestational trophoblastic disease
8. Have knowledge of first trimester screening tests

Skills:

Fellows should be able to:

1. Recognize the features of an early intrauterine gestational sac (halo, eccentric location etc.)
2. Identify normal structure within the gestational sac: yolk sac, embryo, amniotic cavity.
3. Measure size of gestational sac, and crown rump length and where appropriate yolk sac
4. Identify early cardiac activity and measure heart rate using M-mode
5. Interpret the heart rate in the clinical context
6. Establish the diagnosis of multiple pregnancy with confidence, and assess chorionicity and amnionicity
7. Diagnose early embryonic fetal demise based on assessment of gestational sac size and/or crown rump length. Identify, assess and measure retained products of conception in women with incomplete miscarriages
8. Correlate clinical, morphological and biochemical findings in women with pregnancy of unknown location.
9. Identify tubal and non-tubal ectopic pregnancy.
10. Assess a woman with suspicious molar pregnancy, i.e. evaluate the adnexa in a systematic and effective way, identify the site and number of corpora lutea etc.
11. Counsel the couple appropriately.

Teaching and practical module (5):
- Ultrasound sessions – Infertility monitoring sessions (4 per week)
- Log of all ultrasounds performed
- Documented discussion of the normal and abnormal (1 hour per week)

7. MENOPAUSE

The fellow will encounter menopausal women in the clinic.

Fellows should

1. Have knowledge of the physiology and endocrinology of menopause.
2. Have knowledge of hormonal replacement therapy; understand the controversies, side effects and complications
3. Be familiar with various diagnostic tests, their indications and contraindications, their limitations, source of errors and interpretation.
4. Know how to manage postmenopausal bleeding, and other menopausal symptoms
5. Know how to interpret laboratory results in menopausal women.

Skills

The fellow should be able to:

1. Effectively and gently perform transvaginal ultrasound scan in postmenopausal women with vaginal atrophy
2. Effectively scan ovaries with regard to early findings of ovarian tumors
3. Perform endometrial sampling in women with postmenopausal bleeding.

Teaching and practical module (5):
- Ultrasound sessions – general gynecology (4 per week)
- Log of all ultrasounds performed
- Documented discussion of the normal and abnormal (1 hour per week)
2. RESEARCH METHODOLOGY AND STATISTICS

The trainee must have knowledge of research methodology and relevant statistical methods to ensure fulfilling academic goals of the program and continuing self directed education.

A detailed knowledge is expected of:

• experimental design
• sampling techniques
• computation of central tendency, variance and dispersion (including standard deviation, standard error)
• statistical testing including paired and unpaired “T” test, correlation, linear and multiple regression analysis
• analysis of variance
• calculation of sensitivity, specificity, positive and negative predictive value
• calculation of an appropriate line of best fit
• probability distributions
• correlation
• multivariate analysis

Research Project:

Research topic to be approved in first 2 months of training, with one morning or afternoon a week dedicated to research project for the subsequent six months and thereafter the time allocated should be utilized to write the research and present it in a national or international meeting and or publish in a peer-reviewed journal

• must consist of work in the area of or pertaining to the reproductive ultrasound subspecialty
• original research work at a standard to be accepted in a peer-reviewed journal
• a project published in a peer-reviewed journal with an impact factor of ≥ 2 will not need to be formally assessed
• research paper must be submitted at least a month before completion of fellowship
• must have been finally approved at least two months prior to the date of the oral examination
• case reports and review articles not acceptable as a research project in themselves

Training requirements:

• completion of an approved grief counseling course or ‘breaking bad news’ seminar (1-2 days)
• attendance at a minimum of 24 infertility clinics and 24 general gynecology clinics
• attendance at an approved lecture course on human genetics and embryology (4 hours)
• courses in bioethics and biostatistics (mandatory)
• minimum of one day in a genetics laboratory
• weekly attendance at clinical meetings involving clinical management of infertility patients and general gynecology
• personal performance of minimum numbers of a variety of scans and procedures and log them on a day to day basis
• trainees must meet the following minimum training requirements by personally performing:
  • a minimum of 500 gynaecological scans per year
  • a minimum of 100 interventional procedures (such as sonohysterogram, cyst drainage, oocyte collection, ultrasound guided embryo transfer) per year

Evaluation and assessment:

There will be standard monthly, six monthly evaluations performed based on CanMED evaluation provided as standard for all McGill residencies.

Appendix 1

Elective at True North Imaging, Toronto

True North Imaging are imaging centres run specifically for women’s health. There are 20 clinics in the Greater Toronto Area (GTA), dedicated primarily to OB/GYN and infertility imaging. They are the imaging providers at 6 fertility clinics and satellites in the GTA. They perform approximately 2000 studies per day, including 50,000 3D ultrasounds per year as well as 15,000 sonohysterograms. All fertility sonohysterograms (10,000 per year) are done both 2D and 3D with tubal patency and 20 of the 70 ultrasound machines are 3D units and they are routinely used in every fertility evaluation.

Dr Alex Hartmann is the radiologist and director of these clinics. He currently holds the Canadian Fertility and Andrology Society (CFAS) Imaging Chair, as well as the past ASRM Imaging Special Interest Group(SIG) Chair and the chair of the combined AIUM/ASRM 2009 Post-Graduate Reproductive Imaging Course.

He is the main gynecological imaging instructor for the Dept of OB/GYN at U of Toronto, however, that usually only amounts to a single resident once a week. His teaching is usually done while doing sonohysterograms. They book 60-65 sonohysterograms each day that he is at our main site. He uses the sono day as a 7 hour teaching session for the residents and fellows.

CLINICAL PERIOD – There is plenty of capacity in these clinics. Teaching can be done by Dr Hartmann as well as our sonographer instructors. The sonographers are highly trained, have excellent clinical knowledge and know more about the machines than the clinicians. They can also schedule the fellows at different sites, as different locations employ slightly different protocols.

The fellows can be given as much experience as they want in general GYN imaging, as well as perimenopausal scanning. We do large volumes of all stages of OB ultrasound as well. Both 2D imaging and 3D would be emphasized.

RESEARCH PERIOD - The fellows could assist them with research that they are undertaking, or use their clinics, resources, or patient volumes to conduct their own research initiatives. In the past year they have performed research on sonohysterography, 3D imaging, 3D sonos, pelvic pain, adenomyosis, PCO and endometrial polyps.