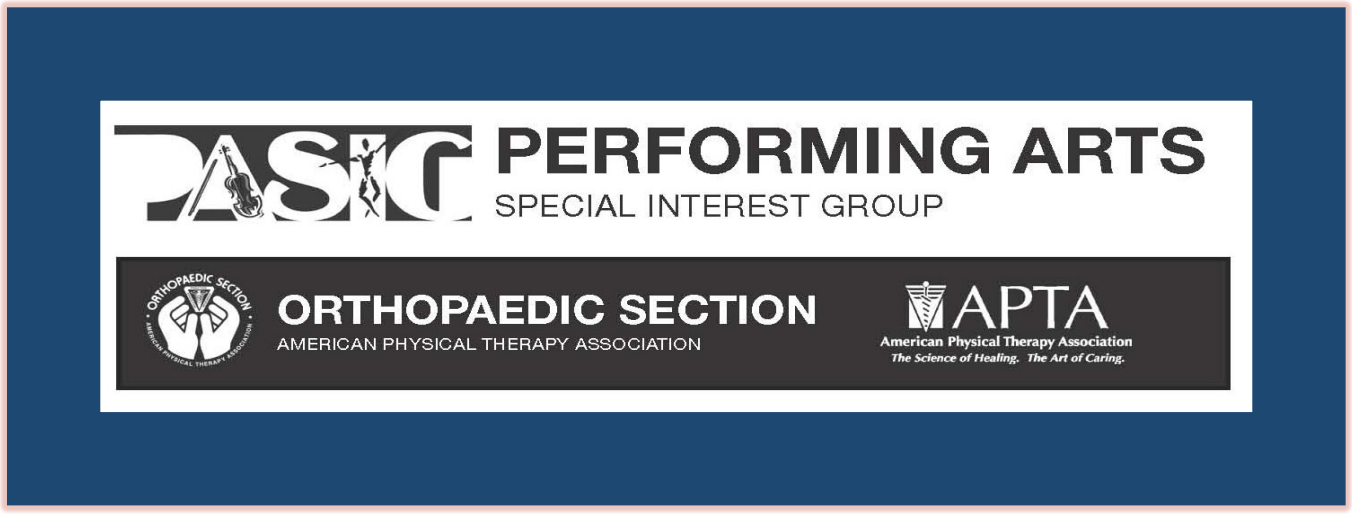

PASIG MONTHLY CITATION BLAST: No. 115 **May 2016**

Dear Performing Arts SIG members:

Upcoming Conferences! We look forward to providing more programming at conferences in 2017. Upcoming events for the Orthopaedic Section are CSM 2017 on Feb 15-17 in San Antonio, TX, and the 2017 Annual Conference in San Diego, CA at the Hyatt Regency Mission Bay on April 20-22.

Looking for new committee members! There is room for new committee members, and students are welcome to participate. Please refer to the list below for contact information.

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Elizabeth Chesarek, Membership Chair	2016-2018	echesarek@gmail.com

Looking for great residency and fellowship opportunities? See below:

The Harkness Center for Dance Injuries Residency Program is accepting applications for the 2016-2017 year! A WONDERFUL opportunity:

The NYU Langone Medical Center (NYULMC) Harkness Center for Dance Injuries is a clinical site for NYU Steinhardt School of Education's Orthopedic Physical Therapy Residency (ORP). The ORP is a 12-month program that provides the Resident with an intensive, individualized experience in orthopedic physical therapy and dance medicine. The goal of the residency program, which follows the guidelines and accreditation standards of the American Physical Therapy Association (APTA), is to enable the Resident to develop the advanced clinical skills necessary to provide a superior level of patient care. Upon completion of the residency program, the Resident will have gained the knowledge and experience to be a competent advanced practitioner, and be qualified to sit for board certification in Orthopedics (OCS). Please note that all applicants must apply to New York University's Orthopedic Physical Therapy residency program and also be interviewed and accepted by the Harkness Center for Dance Injuries. Please visit http://steinhardt.nyu.edu/pt/opt and http://hjd.med.nyu.edu/harkness/healthcare-professionals for more information.

Interested in a Performing Arts Fellowship? The American Board of Physical Therapy Residency and Fellowship Education (ABPTFRE) has approved the PASIG Description of Specialist Practice (DSP) for the Performing arts as an area of study. We are now working with the ABPTFRE to turn the DSP into a Description of Fellowship Practice (DFP). We anticipate the DFP will be available online by June 2016. This means that sites can begin forming fellowships in dance medicine, music medicine, theater medicine, etc. The PASIG will provide the fellowship criteria for accreditation. We may have a meeting on creating a performing arts fellowship at CSM 2017 and/or the 2017 Orthopaedic Section annual meeting. Please contact Rosie Canizares, Mariah Nierman, and Laurel Abbruzzese if interested.

Current PASIG members, please remember to update your membership: https://www.orthopt.org/login.php?forward_url=/surveys/membership_directory.php

Keep up with us on Facebook by contacting Dawn Doran. It is a closed group, so you need to contact Dawn first. Keep up with us and post on Twitter: We are **PT4Performers.** https://twitter.com/PT4Performers

Call for case reports: If you have a brief, clinically-focused case report on a performing arts PT patient, or a clinical commentary, please contact Annette Karim to submit your writing for the next Orthopaedic Physical Therapy Practice Magazine: neoluvsonlyme@aol.com

WE NEED MORE CONTRIBUTORS TO OUR MONTHLY CITATION BLASTS!!!!
Past Monthly citation blasts are available, with citations and EndNote file, listed on the website:
http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes

TOPICS THAT HAVE BEEN COVERED RECENTLY INCLUDE:
Femoroacetabular Impingement (current edition)
Hand and Wrist Conditions in Gymnasts
Factors in Optimal Turnout
Achilles Tendinopathy
Biomechanics and Posture in Musicians
Pilates
ACL Injuries in Dancers
Patellofemoral Pain and Dance
Neural Entrapments Found Among Musicians
Stress Fractures of the Foot and Ankle
Dry Needling
Dynamic Warm Up and Stretching
Platelet Rich Plasma Injections
Back Pain in Dancers

If you are interested in contributing by writing a citation blast or joining the research committee, contact me at lbreising@gmail.com.

Sincerely,

Laura

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PERFORMING ARTS CONTINUING EDUCATION, CONFERENCES, AND RESOURCES

Musician Health Series, Janice Ying, PT, DPT, OCS
Glendale Adventist Therapy and Wellness Center, Los Angeles area (Eagle Rock), CA
http://www.musicianshealthcorner.com/
Healthy Musician Series - Overuse

Orthopaedic Section Independent Study Course. *20.3 Physical Therapy for the Performing Artist*.
Monographs are available for:
- Figure Skating (J. Flug, J. Schneider, E. Greenberg),
- Artistic Gymnastics (A. Hunter-Giordano, Pongetti-Angeletti, S. Voelker, TJ Manal), and
- Instrumentalist Musicians (J. Dommerholt, B. Collier).

Contact: Orthopaedic Section at: www.orthopt.org

Orthopaedic Section-American Physical Therapy Association,
Performing Arts SIG
http://www.orthopt.org/content/special_interest_groups/performing_arts
Performing Arts Citations and Endnotes
http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes

ADAM Center
http://www.adamcenter.net/
Publications:
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Conference abstracts:
http://www.adamcenter.net/#!vstc0=conferences

Dance USA
http://www.danceusa.org/
Research resources:
http://www.danceusa.org/researchresources
Professional Dancer Annual Post-Hire Health Screen:
http://www.danceusa.org/dancerhealth

Dancer Wellness Project
http://www.dancerwellnessproject.com/
Becoming an affiliate:
http://www.dancerwellnessproject.com/Information/BecomeAffiliate.aspx

Harkness Center for Dance Injuries, Hospital for Joint Diseases
http://hjd.med.nyu.edu/harkness/
Continuing education:

http://hjd.med.nyu.edu/harkness/education/healthcare-professionals/continuing-education-courses-cme-and-ceu
Resource papers:
http://hjd.med.nyu.edu/harkness/dance-medicine-resources/resource-papers-and-forms
Links:
http://hjd.med.nyu.edu/harkness/dance-medicine-resources/links
Informative list of common dance injuries:
http://hjd.med.nyu.edu/harkness/patients/common-dance-injuries
Research publications:
http://hjd.med.nyu.edu/harkness/research/research-publications

International Association for Dance Medicine and Science (IADMS)
http://www.iadms.org/
Resource papers:
http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=186
Links:
http://www.iadms.org/displaycommon.cfm?an=5
Medicine, arts medicine, and arts education organization links:
http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=5
Publications:
http://www.iadms.org/displaycommon.cfm?an=3

Performing Arts Medicine Association (PAMA)
http://www.artsmed.org/
http://www.artsmed.org/symposium.html
Interactive bibliography site:
http://www.artsmed.org/bibliography.html
Related links:
http://www.artsmed.org/relatedlinks.html
Member publications:
http://artsmed.org/publications.html

(Educators, researchers, and clinicians, please continue to email your conference and continuing education information to include in future blasts)

Femoroacetabular Impingement (FAI)

Femoroacetabular impingement (FAI) is a common cause of groin pain in dancers and gymnasts. Individuals with FAI will typically present with anterior hip/groin pain with impaired hip flexion and internal rotation ROM. FAI is believed to be associated with intra-articular pathology that can lead to osteoarthritis of the hip. One study found a high prevalence of cam and pincer deformities; as well as, dysplasia in a professional ballet company. Some of the studies presented below

report a high frequency of impingement in the superior and posterosuperior area of the hip, in addition to, some subluxation during common dance movements. However, the majority of individuals who show pathological changes via MRI and/or radiographs are not symptomatic. But when symptoms occur conservative care is essential before considering surgical intervention. Research supports performing inferior and lateral hip joint mobilization followed-up with a self-mobilization for the patient's HEP. While not FAI specific, studies showing the best exercises for posterolateral hip strengthening have been included. Research is lacking in our field to include performing arts related neuromuscular reeducation, strengthening protocol and education.

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Boren K, Conrey C, Le Conguic J, Paprocki L, Voight M, Robinson TK. Electromyographic analysis of gluteus medius and gluteus maximus during rehabilitation exercises. *Int J Sports Phys Ther.* 2011 Sep;6(3):206-223.

PURPOSE/BACKGROUND: Previous research studies by Bolga, Ayotte, and Distefano have examined the level of muscle recruitment of the gluteal muscles for various clinical exercises; however, there has been no cross comparison among the top exercises from each study. The purpose of this study is to compare top exercises from these studies as well as several other commonly performed clinical exercises to determine which exercises recruit the gluteal muscles, specifically the gluteus medius and maximus, most effectively.
METHODS: Twenty-six healthy subjects participated in this study. Surface EMG electrodes were placed on gluteus medius and maximus to measure muscle activity during 18 exercises. Maximal voluntary muscle contraction (MVIC) was established for each muscle group in order to express each exercise as a percentage of MVIC and allow standardized comparison across subjects. EMG data were analyzed using a root-mean-square algorithm and smoothed with a 50 millisecond time reference. Rank ordering of the exercises was performed utilizing the average percent MVIC peak activity for each exercise.
RESULTS: Twenty-four subjects satisfied all eligibility criteria and consented to participate in the research study. Five of the exercises produced greater than 70%MVIC of the gluteus medius muscle. In rank order from highest EMG value to lowest, these exercises were: side plank abduction with dominant leg on bottom (103%MVIC), side plank abduction with dominant leg on top (89%MVIC), single limb squat (82%MVIC), clamshell (hip clam) progression 4 (77%MVIC), and font plank with hip extension (75%MVIC). Five of the exercises recruited gluteus maximus with values greater than 70%MVIC. In rank order from highest EMG value to lowest, these exercises were: front plank with hip extension (106%MVIC), gluteal

squeeze (81%MVIC), side plank abduction with dominant leg on top (73%MVIC), side plank abduction with dominant leg on bottom (71%MVIC), and single limb squat (71%MVIC). Four of the exercises produced greater than 70%MVIC for both gluteus maximus and medius muscles.
CONCLUSIONS: Higher %MVIC values achieved during performance of exercises correlate to muscle hypertrophy. By knowing the %MVIC of the gluteal musculature that occurs during various exercises, potential for strengthening of the gluteal muscles can be inferred. Additionally, exercises may be rank ordered to appropriately challenge the gluteal musculature during rehabilitation.

Chakraverty JK, Snelling NJ. Anterior hip pain – have you considered femoroacetabular impingement? *Int J Osteopath Med.* 2012 March;15(1):22-27.
ABSTRACT: Anterior hip pain is a frequent presentation in both primary care and musculoskeletal practice. Common diagnoses of anterior hip pain include iliopsoas tendinopathy and bursitis, snapping hip syndrome, osteoarthritis of the hip and sacro-iliac joint dysfunction or spinal referred pain. More potentially serious conditions including inguinal hernias, avascular necrosis of the femoral head and psoas abcess all need to be considered. One cause of anterior hip pain is femoroacetabular impingement (FAI). Here follows a short review of the typical clinical presentations, imaging features and management options of FAI. The possible role of osteopathy in the management of this condition will also be briefly discussed.

Charbonnier C, Kolo FC, Duthon VB, Magnenat-Thalmann N, Becker CD, Hoffmeyer P, Menetry J. Assessment of congruence and impingement of the hip joint in professional ballet dancers: a motion capture study. *Am J Sports Med.* 2011 Mar;39(3):557-66. doi: 10.1177/0363546510386002. Epub 2010 Dec 15.
BACKGROUND**:** Early hip osteoarthritis in dancers could be explained by femoroacetabular impingements. However, there is a lack of validated noninvasive methods and dynamic studies to ascertain impingement during motion. Moreover, it is unknown whether the femoral head and acetabulum are congruent in typical dancing positions.
HYPOTHESIS**:** The practice of some dancing movements could cause a loss of hip joint congruence and recurrent impingements, which could lead to early osteoarthritis.
STUDY DESIGN: Descriptive laboratory study.
METHODS**:** Eleven pairs of female dancer's hips were motion captured with an optical tracking system while performing 6 different dancing movements. The resulting computed motions were applied to patient-specific hip joint 3-dimensional models based on magnetic resonance images. While visualizing the dancer's hip in motion, the authors detected impingements using computer-assisted techniques. The range of motion and congruence of the hip joint were also quantified in those 6 recorded dancing movements.
RESULTS: The frequency of impingement and subluxation varied with the type of movement. Four dancing movements (développé à la seconde, grand écart facial,

grand écart latéral, and grand plié) seem to induce significant stress in the hip joint, according to the observed high frequency of impingement and amount of subluxation. The femoroacetabular translations were high (range, 0.93 to 6.35 mm). For almost all movements, the computed zones of impingement were mainly located in the superior or posterosuperior quadrant of the acetabulum, which was relevant with respect to radiologically diagnosed damaged zones in the labrum. All dancers' hips were morphologically normal.
CONCLUSION: Impingements and subluxations are frequently observed in typical ballet movements, causing cartilage hypercompression. These movements should be limited in frequency.
CLINICAL RELEVANCE: The present study indicates that some dancing movements could damage the hip joint, which could lead to early osteoarthritis.

Clohisy JC, Hunt DM, Harris-Hayes M. Clinical presentation of patients with symptomatic anterior hip impingement. *Clin Orthop Relat Res.* 2009;467:638-644. DOI 10.2007/s11999-008-0680-y
ABSTRACT**:** Femoroacetabular impingement (FAI) is considered a cause of labrochondral disease and secondary osteoarthritis. Nevertheless, the clinical syndrome associated with FAI is not fully characterized. We determined the clinical history, functional status, activity status, and physical examination findings that characterize FAI. We prospectively evaluated 51 patients (52 hips) with symptomatic FAI. Evaluation of the clinical history, physical exam, and previous treatments was performed. Patients completed demographic and validated hip questionnaires (Baecke et al., SF-12, Modified Harris hip, and UCLA activity score). The average patient age was 35 years and 57% were male. Symptom onset was commonly insidious (65%) and activity-related. Pain occurred predominantly in the groin (83%). The mean time from symptom onset to definitive diagnosis was 3.1 years. Patients were evaluated by an average 4.2 healthcare providers prior to diagnosis and inaccurate diagnoses were common. Thirteen percent had unsuccessful surgery at another anatomic site. On exam, 88% of the hips were painful with the anterior impingement test. Hip flexion and internal rotation in flexion were limited to an average 97° and 9°, respectively. The patients were relatively active, yet demonstrated restrictions of function and overall health. These data may facilitate diagnosis of this disorder.
LEVEL OF EVIDENCE: Level II, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

Duthon VB, Charbonnier C, Kolo FC, Magnenat-Thalmann N, Becker CD, Bouvet C, Coppens E, Hoffmeyer P, Menetry J. Correlation of clinical and magnetic resonance imaging findings in hips of elite female ballet dancers. *Arthroscopy*. 2013 Mar;29(3): 411-9. doi: 10.1016/j.arthro.2012.10.012. Epub 2013 Jan 16.
PURPOSE**:** To understand why professional female ballet dancers often complain of inguinal pain and experience early hip osteoarthritis (OA). Goals were to examine clinical and advanced imaging findings in the hips of dancers compared with those in a matched cohort of nondancers and to assess the femoral head translation in the forward split position using magnetic resonance imaging (MRI).

METHODS**:** Twenty professional female ballet dancers and 14 active healthy female individuals matched for age (control group) completed a questionnaire on hip pain and underwent hip examination with impingement tests and measurement of passive hip range of motion (ROM). All had a pelvic 1.5 T MRI in the back-lying position to assess femoroacetabular morphologic features and lesions. For the dancers, additional MR images were acquired in the split position to evaluate femoroacetabular congruency.
RESULTS**:** Twelve of 20 dancers complained of groin pain only while dancing; controls were asymptomatic. Dancers' passive hip ROM was normal. No differences in α neck angle, acetabular depth, acetabular version, and femoral neck anteversion were found between dancers and controls. MRI of dancers while performing splits showed a mean femoral head subluxation of 2.05 mm. MRI of dancers' hips showed labral tears, cartilage thinning, and herniation pits, located in superior and posterosuperior positions. Lesions were the same for symptomatic and asymptomatic dancers. Controls had proportionally the same number of labral lesions but in an anterosuperior position. They also had 2 to 3 times fewer cartilage lesions and pits than did dancers.
CONCLUSIONS: The results of our study are consistent with our hypothesis that repetitive extreme movements can cause femoral head subluxations and femoroacetabular abutments in female ballet dancers with normal hip morphologic features, which could result in early OA. Pathologic changes seen on MRI were symptomatic in less than two thirds of the dancers.
LEVEL OF EVIDENCE: Level IV, therapeutic case series.

Giphart JE, Stull JD, LaPrade RF, Wahoff MS, Philippon. Recruitment and activity of the pectineus and piriformis muscles during hip rehabilitation exercises: an electromyography study. *Am J Sports Med.* 2012 July;40(7):1654-1663. doi: 10.1177/0363546512443812
BACKGROUND: The pectineus muscle has been reported to function primarily as a hip flexor and secondarily as a hip internal rotator; the piriformis muscle has been reported to function as an abductor and external rotator of the hip. The recruitment and activations of these muscles during hip rehabilitation exercises have not been detailed.
HYPOTHESIS: The authors hypothesized that they would measure the highest pectineus activation during exercises involving hip flexion, with moderate pectineus activation during exercises with hip internal rotation. They also hypothesized that they would measure the highest piriformis activation during exercises involving hip abduction and/or external rotation.
STUDY DESIGN: Descriptive laboratory study.
METHODS: Ten healthy volunteers completed 13 hip rehabilitation exercises with electromyography (EMG) electrodes inserted under ultrasound guidance into the pectineus and piriformis muscle bellies. The EMG signals were recorded and exercise activation levels were reported as a percentage of a maximum voluntary contraction (MVC).
RESULTS: Both the highest peak pectineus activation (62.8% ± 26.6% MVC) and the highest mean pectineus activation (33.1% ± 17.4% MVC) were measured during the

supine hip flexion exercise. Moderate activation was found during the single- and double-legged bridge and both phases of the stool hip rotation exercise. The highest peak piriformis activation was observed in the single-legged bridge (MVC, 35.7% ± 25.7%), and the highest mean piriformis activation was observed in the prone heel squeeze (MVC, 24.3% ± 8.2%). Similar moderate activation levels were found for single-legged hip abduction and resisted hip extension.
CONCLUSION: The pectineus was highly activated during hip flexion exercises and moderately activated during exercises requiring rotational hip stabilization in either direction, rather than with internal hip rotation only. The piriformis was most activated during static external rotation and abduction while the participants' hips were in slight extension. These observations indicate that the pectineus and piriformis are both muscles that contribute to hip stabilization.
CLINICAL RELAVENCE: The findings indicate that the pectineus and piriformis function as hip-stabilizing muscles and can be used to specifically address pectineus and piriformis muscle rehabilitation. The authors believe that strengthening and conditioning of these muscles should aid in the restoration of hip function and stability after injury or arthroscopic surgery.

Halim A, Badrinath R, Carter CW. The importance of sex of patient in the management of femoroacetabular impingement. *Am J Orthop (Belle Mead NJ).* 2015 Apr;44(4):172-5.
ABSTRACT: Femoroacetabular impingement (FAI), a recently described hip condition in adolescents and young adults, typically manifests as activity-related hip pain. Characteristic physical findings include limited passive internal rotation of the affected hip and a positive impingement sign. Diagnostic imaging may reveal cam and/or pincer lesions, and associated intra-articular pathology (eg, labral tear, chondral damage) is common. When nonoperative treatment fails to adequately alleviate symptoms, surgery may be warranted. Both open and arthroscopic techniques have been effective. As our understanding of FAI continues to evolve, sex-based differences in incidence, presentation, and outcomes for patients with FAI have become apparent. Understanding the different ways in which males and females may present with FAI and then changing clinical practice patterns to accommodate these sexual dimorphisms will likely result in improved outcomes for each patient with symptomatic FAI.

Harris JD, Gerrie BJ, Varner KE, Lintner DM, McCulloch PC. Radiographic prevalence of dysplasia, cam and pincer deformities in elite ballet. *Am J Sports Med*. 2016 Jan;44(1):20-7. doi: 10.1177/0363546515601996. Epub 2015 Aug 31.
BACKGROUND**:** The demands of hip strength and motion in ballet are high. Hip disorders, such as cam and pincer deformities or dysplasia, may affect dance performance. However, the prevalence of these radiographic findings is unknown.
PURPOSE: To determine the prevalence of radiographic cam and pincer deformities, borderline dysplasia, and dysplasia in a professional ballet company.
STUDY DESIGN: Cross-sectional study; Level of evidence, 3.

METHODS**:** An institutional review board-approved cross-sectional investigation of a professional ballet company was undertaken. Male and female adult dancers were eligible for inclusion. Four plain radiographs were obtained (standing anteroposterior pelvis, bilateral false profile, and supine Dunn 45°) and verified for adequacy. Cam and pincer deformities, dysplasia, borderline dysplasia, and osteoarthritis were defined. All plain radiographic parameters were measured and analyzed on available radiographs. Student t test, chi-square test (and Fisher exact test), and Spearman correlation analyses were performed to compare sexes, groups, and the effect of select radiographic criteria.
RESULTS**:** A total of 47 dancers were analyzed (21 males, 26 females; mean age (±SD), 23.8 ± 5.4 years). Cam deformity was identified in 25.5% (24/94) of hips and 31.9% (15/47) of subjects, with a significantly greater prevalence in male dancers than females (48% hips and 57% subjects vs 8% hips and 12% subjects; $P < .001$ and $P = .001$, respectively). Seventy-four percent of subjects had at least 2 of 6 radiographic signs of pincer deformity. Male dancers had a significantly greater prevalence of both prominent ischial spine and posterior wall signs ($P = .001$ and $P < .001$, respectively), while female dancers had a significantly greater prevalence of coxa profunda (85% female hips vs 26% male hips; $P < .001$). Eighty-nine percent of subjects had dysplasia or borderline dysplasia in at least 1 hip (37% dysplastic), with a significantly greater prevalence of dysplasia or borderline dysplasia in female versus male dancers (92% female hips vs 74% male hips; $P < .022$). Further, in those with dysplasia or borderline dysplasia, 92% of female and 82% of male dancers had bilateral findings.
CONCLUSION: In this professional ballet company, a high prevalence of radiographic abnormalities was found, including cam and pincer deformity and dysplasia. The results also revealed several sex-related differences of these abnormalities in this unique population. The long-term implications of these findings in this group of elite athletes remain unknown, and this issue warrants future investigation.

Kivlan BR, Carcia CR, Clemente FR, Phelps AL, Martin RL. Reliability and validity of functional performance tests in dancers with hip dysfunction. *Int J Sports Phys Ther*. 2013 Aug;8(4):360-369.
STUDY DESIGN: Quasi-experimental, repeated measures.
PURPOSE/BACKGROUND: Functional performance tests that identify hip joint impairments and assess the effect of intervention have not been adequately described for dancers. The purpose of this study was to examine the reliability and validity of hop and balance tests among a group of dancers with musculoskeletal pain in the hip region.
METHODS: Nineteen female dancers (age: 18.90±1.11 years; height: 164.85±6.95 cm; weight: 60.37±8.29 kg) with unilateral hip pain were assessed utilizing the cross-over reach, medial triple hop, lateral triple hop, and cross-over hop tests on two occasions, 2 days apart. Test-retest reliability and comparisons between the involved and uninvolved side for each respective test were determined.
RESULTS: Intra-class correlation coefficients for the functional performance tests ranged from 0.89-0.96. The cross-over reach test had a SEM of 2.79 cm and a MDC of 7.73 cm. The medial and lateral triple hop tests had SEM values of 7.51 cm and 8.17

cm, and MDC values of 20.81 cm and 22.62 cm, respectively. The SEM was 0.15 seconds and the MDC was 0.42 seconds for the cross-over hop test. Performance on the medial triple hop test was significantly less on the involved side (370.21±38.26 cm) compared to the uninvolved side (388.05±41.49 cm); $t(18) = -4.33$, $p<0.01$. The side-to-side comparisons of the cross-over reach test (involved mean=61.68±10.9 cm; uninvolved mean=61.69±8.63 cm); $t(18) = -0.004$, $p=0.99$, lateral triple hop test (involved mean=306.92±35.79 cm; uninvolved mean=310.68±24.49 cm); $t(18) = -0.55$, $p=0.59$, and cross-over hop test (involved mean=2.49±0.34 seconds; uninvolved mean= 2.61±0.42 seconds; $t(18) = -1.84$, $p=0.08$) were not statistically different between sides.
CONCLUSION**:** The functional performance tests used in this study can be reliably performed on dancers with unilateral hip pain. The medial triple hop test was the only functional performance test with evidence of validity in side-to-side comparisons. These results suggest that the medial triple hop test may be a reliable and valid functional performance test to assess impairments related to hip pain among dancers.
LEVEL OF EVIDENCE: 3b. Non-consecutive cohort study

Kolo FC, Charbonnier C, Pfirrmann CW, Duc SR, Lubbeke A, Duthon VB, Magnenat-Thalmann N, Hoffmeyer P, Menetrey J, Becker CD. Extreme hip motion in professional ballet dancers: dynamic and morphological evaluation based on magnetic resonance imaging*. Skeletal Radiol*. 2013 May;42(5):689-98. doi: 10.1007/s00256-012-1544-9. Epub 2012 Nov 29.
OBJECTIVE**:** To determine the prevalence of femoroacetabular impingement (FAI) of the cam or pincer type based on magnetic resonance imaging (MRI) in a group of adult female professional ballet dancers, and to quantify, in vivo, the range of motion (ROM) and congruence of the hip joint in the splits position.
MATERIALS AND METHODS: Institutional review board approval and informed consent from each volunteer were obtained. Thirty symptomatic or asymptomatic adult female professional ballet dancers (59 hips) and 14 asymptomatic non-dancer adult women (28 hips, control group) were included in the present study. All subjects underwent MRI in the supine position, while, for the dancers, additional images were acquired in the splits position. Labral abnormalities, cartilage lesions, and osseous abnormalities of the acetabular rim were assessed at six positions around the acetabulum. A morphological analysis, consisting of the measurement of the α angle, acetabular depth, and acetabular version, was performed. For the dancers, ROM and congruency of the hip joint in the splits position were measured.
RESULTS**:** Acetabular cartilage lesions greater than 5 mm were significantly more frequent in dancer's hips than in control hips (28.8 vs 7.1%, $p = 0.026$), and were mostly present at the superior position in dancers. Distribution of labral lesions between the dancers and the control group showed substantially more pronounced labral lesions at the superior, posterosuperior, and anterosuperior positions in dancers (54 lesions in 28 dancer's hips vs 10 lesions in 8 control hips). Herniation pits were found significantly more often ($p = 0.002$) in dancer's hips ($n = 31$, 52.5%), 25 of them being located in a superior position. A cam-type morphology was found

for one dancer and a retroverted hip was noted for one control. Femoroacetabular subluxations were observed in the splits position (mean: 2.05 mm).
CONCLUSION**:** The prevalence of typical FAI of the cam or pincer type was low in this selected population of professional ballet dancers. The lesions' distribution, mostly superior, could be explained by a "pincer-like" mechanism of impingement with subluxation in relation to extreme movements performed by the dancers during their daily activities.

Larson CM, Stone RM. Current concepts and trends for operative treatment of FAI: hip arthroscopy. *Curr Rev Musculoskelet Med*. 2013;6:242-249. Doi: 10.1007/s12178-013-9170-2
ABSTRACT: There has been an increasing body of literature regarding arthroscopic management of femoroacetabular impingement (FAI). Refinement of arthroscopic techniques has allowed for more complete management of FAI, and meta-analysis and systematic reviews have shown comparable outcomes to surgical hip dislocation with appropriate indications. There are still, however, pathomorphologies that are not accessible or much more challenging to address arthroscopically, and open corrective procedures should be considered in these situations. Extra-articular FAI is receiving increased attention and can be secondary to anterior inferior iliac spine/subspine impingement, trochanteric-pelvic impingement, and ischio-femoral impingement. Femoral and acetabular version and their impact on hip stability as well as the concept of impingement induced instability are being increasingly recognized. Acetabular labral and capsular management and repair techniques have also received increased attention. Finally, 3-dimensional imaging and dynamic software analysis are beginning to emerge as potential tools to better evaluate hip pathomorphology.

Loudon JK, Reiman MP. Conservative management of femoroacetabular impingement (FAI) in the long distance runner. *Physical Therapy in Sport*. 2014 May;15(2):82-90.
ABSTRACT: Femoroacetabular impingement (FAI) is one cause of anterior hip pain that may occur in a long distance runner. By definition FAI is due to bony abutment of the femoral neck and the acetabulum. This occurs primarily with end-ranges of hip flexion and adduction. An understanding of running mechanics and performing a thorough examination will help the clinician provide an appropriate intervention for these athletes. A course of conservative treatment that includes patient education, manual therapy and strengthening should be tried prior to surgical management.

Malloy P, Malloy M, Draovitch P. Guidelines and pitfalls for the rehabilitation following hip arthroscopy. *Curr Rev Musculoskelet Med.* Sep 2013;6(3):235-241.
ABSTRACT**:** Rehabilitation guidelines following hip arthroscopy have been presented in the literature with common themes consisting of initial protection, restoration of lumbo-pelvic stability, neuromuscular re-education, and return to sport training. The purpose of this review is to present hip arthroscopy guidelines in 4 phases and to address common pitfalls that may delay the rehabilitative process.

The goal of phase 1 should be to protect healing tissues through activity modifications. Phase 2 intends to return the patient to pain-free community ambulation without compensation or irritation. A review of hip muscular actions during gait is presented to guide exercise progressions during this phase. Phase 3 should reestablish neuromuscular control through strength and endurance training to provide the foundation for return to functional activities or sports training progressions. The last phase of rehabilitation is dedicated to reestablishing power, speed, agility, and skill for advanced sports and advanced functions.

Mansell NS, Rhon DI, Marchant BG, Slevin JM, Meyer JL. Two-year outcomes after arthroscopic surgery compared to physical therapy for femoracetabular impingement: A protocol for a randomized clinical trial. ***BMC Musculoskelet Disord.*** **2016 Feb 4;17(1):60. doi: 10.1186/s12891-016-0914-1**

BACKGROUND**:** As the prevalence of hip pathology in the younger athletic population rises, the medical community continues to investigate effective intervention options. Femoracetabular impingement is the morphologically abnormal articulation of the femoral head against the acetabulum, and often implicated in pre-arthritic hip conditions of musculoskeletal nature. Arthroscopic surgical decompression and non-surgical rehabilitation programs focused on strengthening and stability are common interventions. However, they have never been directly compared in clinical trials. The primary purpose of this study will be to assess the difference in outcomes between these 2 commonly utilized interventions for femoracetabular impingement.

METHODS**:** The study will be a single site, non-inferiority, randomized controlled trial comparing two different treatment approaches (surgical and nonsurgical) for FAI. The enrollment goal is for a total of 80 subjects with a diagnosis of femoracetabular impingement that are surgical candidates and have failed 6 weeks of conservative treatment. This will be a convenience sample of consecutive patients that are Tricare beneficiaries and seeking care at Madigan Army Medical Center. Patients that meet the criteria will be screened, provide written consent before enrollment, and then randomized into one of two arms (Group I = hip arthroscopy, Group II = physical therapy). Group I will undergo hip arthroscopy with or without labral repair. Group II will follow an impairment based physical therapy program consisting of 2 sessions per week for 6 weeks. The primary outcome will be the Hip Outcome Score and secondary measures will include the International Hip Outcome Tool and the Global Rating of Change. Measures will be taken at baseline, 6 months, 1 and 2 years. Hip-related healthcare utilization between both groups will also be assessed at the end of 2 years.

DISCUSSION**:** The current evidence to support both surgical and conservative interventions for femoroacetabular impingement is based on low-level research. To date, none of these interventions have been directly compared in a randomized clinical trial. Clinical trials are needed to help establish the value of these interventions in the management of femoracetabular impingement and to help define appropriate clinical pathways.

Moser BR. Hip pain in dancers. *Curr Sports Med Rep*. 2014 Nov-Dec;13(6):383-9. doi: 10.1249/JSR.0000000000000103.

ABSTRACT: Dancers require extreme ranges of motion in their hips. They require this for many styles and performances. Hip pain and hip injury in dancers can lead to lost work and performance time. There are many potential causes for hip pain in the dancer, including dysplasia, hyperlaxity, both intra- and extra-articular impingement, and soft tissue injuries. This article will review the current literature on these topics in dancers and how they can be applied to the dancer patient.

Philippon MJ, Ejnisman L, Ellis HB, Briggs KK. Outcomes 2 to 5 years following hip arthroscopy for femoroacetabular impingement in the patient aged 11 to 16 years. *Arthroscopy*. 2012 Sept; 28(9):1255-1261. doi:10.1016/j.arthro.2012.02.006

PURPOSE: The purpose of this study was to evaluate clinical outcomes after treatment for femoroacetabular impingement in the pediatric and adolescent population with a minimum of 2 years' follow-up.
METHODS: Prospectively collected data on 60 consecutive pediatric and adolescent patients (65 hips), aged 16 years or younger, who underwent hip arthroscopy were retrospectively analyzed. Patients were excluded if they had previous surgery on the hip and if they presented a center-edge angle below 25°.
RESULTS: The mean age at the time of surgery was 15 years (range, 11 to 16 years), and 31% of patients were boys and 69% were girls. The femoral physis was open in 10% of patients, partially closed in 19%, and closed in 71%. Cam impingement was found in 10% of cases, pincer impingement in 15%, and mixed type in 75%. The mean center-edge angle was 36° (95% confidence interval [CI], 34° to 38°), and the mean alpha angle was 64° (95% CI, 60° to 69°). There was a significant association between age and alpha angle (r = 0.324, P = .02). After the index procedure, 8 patients (all girls) needed second-look diagnostic arthroscopies because of intra-articular adhesions. At a mean follow-up of 3 years (range, 2 to 5 years) with 91% follow-up, the modified Harris Hip Score increased from a mean of 57 (95% CI, 51 to 62) to a mean of 91 (95% CI, 88 to 94) (P < .001). The median rating for patient satisfaction with outcome was 10 (range, 5 to 10).
CONCLUSIONS: Hip arthroscopy in the pediatric and adolescent population is a safe procedure, with excellent clinical outcomes at 2 to 5 years. In this study there was an association between alpha angle and age. Clinical scores showed a significant improvement after surgery; however, 13% of patients did require a second procedure for capsulolabral adhesions.
LEVEL OF EVIDENCE: Level IV, therapeutic case series.

Phillippon MJ, Schenker M, Briggs K, Kuppersmith D. Femoroacetabular impingement in 45 professional athletes: associated pathologies and return to sport following arthoscopic decompression. *Knee Surg Sports Traumatol Arthrosc.* 2007 July;15(7):908-914. DOI: 10.1007/s00167-007-0332-x

ABSTRACT: Femoroacetabular impingement (FAI) occurs when an osseous abnormality of the proximal femur (cam) or acetabulum (pincer) triggers damage to the acetabular labrum and articular cartilage in the hip. Although the precise

etiology of FAI is not well understood, both types of FAI are common in athletes presenting with hip pain, loss of range-of-motion, and disability in athletics. An open surgical approach to decompressing FAI has shown good clinical outcomes; however, this highly invasive approach inherently may delay or preclude a high level athlete's return to play. The purpose of this study was to define associated pathologies and determine if an arthroscopic approach to treating FAI can allow professional athletes to return to high-level sport. Hip arthroscopy for the treatment of FAI allows professional athletes to return to professional sport. Between October 2000 and September 2005, 45 professional athletes underwent hip arthroscopy for the decompression of FAI. Operative and return-to-play data were obtained from patient records. Average time to follow-up was 1.6 years (range: 6 months to 5.5 years). Forty two (93%) athletes returned to professional competition following arthroscopic decompression of FAI. Three athletes did not return to play; however, all had diffuse osteoarthritis at the time of arthroscopy. Thirty-five athletes (78%) remain active in professional sport at an average follow-up of 1.6 years. Arthroscopic treatment of FAI allows professional athletes to return to professional sport.

Reinman MP, Matheson JW. Restricted hip mobility: clinical suggestions for self-mobilization and muscle re-education. *Int J Sports Phys Ther.* 2013 Oct;8(5):729-740.
ABSTRACT: Restricted hip mobility has shown strong correlation with various pathologies of the hip, lumbar spine and lower extremity. Restricted mobility can consequently have deleterious effects not only at the involved joint, but throughout the entire kinetic chain. Promising findings are suggesting benefit with skilled joint mobilization intervention for clients with various hip pathologies. Supervised home program intervention, while lacking specifically for the hip joint, are demonstrating promising results in other regions of the body. Application of an accompanying home program for the purpose of complementing skilled, in clinic intervention is advisable for those clients that respond favorably to such methodology.
LEVEL OF EVIDENCE: 5

Sink EL, Gralla J, Ryba A, Dayton M. Clinical presentation of femoroacetabular impingement in adolescents. Clinical presentation of femoroacetabular impingement in adolescents. *J Pediatr Orthop.* 2008 Dec;28(8):806-11. doi: 10.1097/BPO.0b013e31818e194f.
ABSTRACT: Femoroacetabular impingement (FAI) is a recently recognized hip disorder resulting from an abnormal morphology of the proximal femur and acetabulum. This morphology results in increased hip contact forces with hip motion, specifically flexion. This may lead to labral-cartilage injury and pain. The purpose of this study is to describe the clinical presentation and diagnosis of FAI as a cause of hip pain in adolescents. Thirty-five patients with FAI as the etiology of chronic hip pain from one institution were reviewed. The common symptoms, physical examination, and radiographic findings were analyzed. The age range was 13 to 18 years. There were 30 girls and 5 boys. All patients complained of anterior groin pain. All patients performed a sport/activity that contributed to the symptoms

such as dancing. Patients had decreased flexion and limited internal rotation on physical examination. All patients had a positive impingement test. Fifteen patients (43%) had primarily pincer impingement with a crossover sign or acetabular retroversion. Cam impingement was the primary type in 2 patients (6%). There were findings of cam and pincer in 18 patients (51%). Sixteen of 28 patients had a positive labral tear on magnetic resonance imaging (57%). Femoroacetabular impingement is a cause of hip pain in the adolescent population. The diagnosis can be derived from reproducible history, physical examination, and radiographic findings. It is more common in female adolescents, and pincer type is more prevalent.

Spencer-Gardner L, Eischen JJ, Levy BA, Sierra RJ, Engasser WM, Krych AJ. A comprehensive five-phase rehabilitation programme after hip arthroscopy for femoroacetabular impingement. *Knee Surg Sports Traumatol Arthrosc*. Sep 28 2013.

PURPOSE: Recent advancements in the understanding of hip biomechanics have led to the development of techniques to remove bony impingement and repair and/or preserve the labrum during hip arthroscopy. Although much attention in the literature is devoted to diagnosis and treatment, there is little information about post-operative rehabilitation. Therefore, the purpose of this review is to (1) provide a five-phase rehabilitation protocol following arthroscopic treatment for FAI and (2) report clinical and functional outcomes of patients following this protocol at minimum 1-year follow-up, in order to provide the surgeon and therapist with a protocol that is supported by clinical data.

METHODS: All consecutive patients undergoing hip arthroscopy and subsequent five-phase rehabilitation protocol at a single institution from 1 April 2011 to 1 April 2012 were analysed. Inclusion criteria were as follows: no prior ipsilateral hip surgery, completion of the five-phase rehabilitation protocol, minimum 1-year follow-up, and documented outcome scores. Prospective outcomes were assessed with modified Harris hip score (MHHS) and hip outcome score (HOS). RESULTS: Fifty-two patients (19 male and 33 female) met the inclusion criteria with a median age of 42 (range 16–59) years. Mean MHHS, HOS-ADL, and HOS-sport scores at a mean 12.5 (range 12–15) months were 80.1 ± 19.9 (0–100), 83.6 ± 19.2 (13.2–100), and 70.3 ± 27.0 (0–100), respectively.

CONCLUSION: This five-phase rehabilitation programme provides a framework where progression from surgery to increasing post-operative activity level can take place in a predictable manner. Patients following this rehabilitation protocol after hip arthroscopy demonstrated satisfactory clinical and functional outcomes, validating its implementation.

LEVEL OF EVIDENCE: Case series, Level IV.

Wahoff M, Ryan M. Rehabilitation after hip femoroacetabular impingement arthroscopy. *Clin Sports Med.* 2011 April;30(2):463-482. doi:10.1016/j.csm.2011.01.001

ABSTRACT: More than 30,000 hip arthroscopies were performed in 2008. This number is expected to grow at a rate of 15% over the next 5 years, resulting in more

then 70,000 hip arthroscopies performed each year by 2013.1 Hip arthroscopic techniques to repair labral tears and address femoroacetabular impingement (FAI) continue to evolve. Multiple published studies have reported positive surgical outcomes. Although there is evidence to support arthroscopic procedures to address labral tears and FAI, there are few published evidence-based rehabilitation studies dedicated to post- operative rehabilitative care. Pain, loss of motion, changes in muscle strength and motor control, loss of stability, and loss of function can be caused by FAI and labral tear. Hip arthroscopic procedures are used to correct the bony geometry and provide an intact labral complex and ligamentous structure for improved hip congruency. A thorough postoperative rehabilitation program must protect the integrity of these healing tissues, control pain and inflammation, allow for early range of motion (ROM), reduce muscle inhibition, restore neuromuscular control and proprioception, normalize gait, and improve strength. For the athlete, power, speed, and agility are recommended for optimal return to competition. A positive outcome is not necessarily how quickly patients return to their preinjury level of function or sport but the overall longevity and patient satisfaction.

Weber AE, Bedi A, Tibor LM, Zaltz I, Larson CM. The hyperflexible hip: managing hip pain in the dancer and gymnast. *Sports Health.* 2015 Jul;7(4):346-58. doi: 10.1177/1941738114532431.

CONTEXT**:** Dance, gymnastics, figure skating, and competitive cheerleading require a high degree of hip range of motion. Athletes who participate in these sports use their hips in a mechanically complex manner.
EVIDENCE ACQUISITION**:** A search of the entire PubMed database (through December 2013) and additional searches of the reference lists of pertinent articles.
STUDY DESIGN: Systematic review.
LEVEL OF EVIDENCE: Level 3.
RESULTS: Whether innate or acquired, dancers and gymnasts have some hypermobility that allows their hips to be placed in potentially impinging or unstable positions required for their given activity. Such extremes of motion can result in both intra-articular and extra-articular impingement as well as compensatory osseous and muscular pathology. In addition, dancers and gymnasts are susceptible to impingement-induced instability. Dancers with innate generalized hyperlaxity are at increased risk of injury because of their activities and may require longer recovery times to return to play. Both nonoperative and operative treatments (arthroscopic and open) have an important role in returning flexibility athletes to their preoperative levels of sport and dance.
CONCLUSION**:** Because of the extreme hip motion required and the compensatory soft tissue laxity in dancers and gymnasts, these athletes may develop instability, impingement, or combinations of both. This frequently occurs in the setting of subtle pathoanatomy or in patients with normal bony anatomy. With appropriate surgical indications and the correct operative technique, the treating surgeon can anticipate high levels of return to play for the gymnast and dancer with hip pain.
KEYWORDS: dance; femoroacetabular impingement; gymnastics; hip injury; impingement; instability.

Wright AA, Hegedus EJ. Augmented home exercise program for a 37-year-old female with a clinical presentation of femoroacetabular impingement. *Manual Therapy*. 2012 Aug;17(4):358-363.

ABSTRACT: Previous researchers have reported on the use of augmented home exercise programs with potential carry-over effects from manual therapy treatment. While there is no direct evidence to support augmented manual therapy, tangential evidence demonstrates that specific, supervised, and adherent exercises result in improved outcomes. The purpose of this case report is to describe an augmented home program simulating the manual techniques provided by the therapist. A 37-year-old female presented with symptoms and signs consistent with femoroacetabular impingement (FAI). Grade III lateral and inferior femoral glides decreased reported pain from 5/10 to 0/10. Given the immediate response to hip mobilizations, the patient was prescribed standing lateral glides and supine inferior glides of the hip with the use of a belt. During this time, the patient's Lower Extremity Functional Scale score improved from 74 to 78 and she reported increased ability to self-manage her symptoms. The immediate report of decreased pain helped determine the specific home program selected for this individual patient. This case highlights the importance of a specific augmented home exercise program unique to the individual patient resulting in self-management of pain associated with FAI.

Wyss TF, Clark JM, Weishaupt D, Notzli HP. Correlation between internal rotation and bony anatomy in the hip. *Clin Orthop Relat Res.* 2007 July;460:152-8. doi: 10.1097/BLO.0b013e3180399430

ABSTRACT: Femoroacetabular impingement has been implicated as a risk factor for degenerative arthritis in young people with normally concentric hips. On presentation, patients with impingement have groin pain, limited internal rotation in 90[degrees] flexion, and focal articular lesions. We hypothesized that the amount of internal rotation is dictated primarily by the underlying bony anatomy and not secondary to contractures. We compared 23 consecutive patients (32 hips) with 40 asymptomatic control subjects using positional magnetic resonance imaging, physical examination, and a questionnaire regarding symptoms and their commencement. There was a strong correlation between internal rotation in 90[degrees] flexion and the measurable free space between the relevant bony contours on magnetic resonance imaging (r = 0.97) in the patient group and the control subjects. The range of internal rotation is closely related to skeletal anatomy, and internal rotation can be used as a noninvasive tool to predict the risk of impingement. Level of Evidence: Level II, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.