Factors and Patient-reported Outcome Measures Associated With Stress Fracture After Periacetabular Osteotomy

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Introduction
Though periacetabular osteotomy (PAO) is a common and effective procedure used to treat acetabular dysplasia, complications such as stress fractures of the ischium or pubis have been reported. A limited number of studies have investigated stress fracture after PAO, but the results lack consensus and do not thoroughly explore lifestyle factors or patient-reported outcome measures (PROMs). Therefore, this study aimed to (1) determine the percentage of patients and hips that developed a stress fracture after PAO (2) explore pre- and intraoperative factors associated with stress fractures, and (3) determine if PROMs or the minimum clinically important difference (MCID) and the patient acceptable symptom state (PASS) achievement differed between patients with stress fractures and patients without stress fractures.
Methods
Six-hundred-seventy-five hips (546 patients) were treated with PAO with or without hip arthroscopy for symptomatic acetabular dysplasia between February 2016 and October 2024 by a single surgeon in a mature hip preservation practice. Patients who underwent concomitant femoral osteotomy, surgical hip dislocation, or relative neck lengthening were excluded, yielding 90% (608 of 675) of hips from 487 patients as potentially eligible for analysis. 94% (574 of 608) of procedures were performed in female patients. Only patients with minimum 1-year PROMs after their most recent PAO surgery were considered in the PROMs analysis (81% [30 of 37] of stress fracture patients and 81% [365 of 450] of patients without stress fractures). Hip-specific PROMs included the modified Harris hip score (mHHS) and the International Hip Outcome Tool 12 (iHOT-12). For each PROM, higher scores on a scale of 0 to 100 indicated pain and functional improvement. For PAO, the MCID was defined as an outcome change ≥ 18 for the mHHS and ≥ 26 for iHOT-12. PASS was defined as a postoperative score of ≥ 71 for mHHS and ≥ 65 for iHOT-12. Normality was assessed. Hips were considered independent with an intraclass correlation of 0.004. Comparisons between those with and without a stress fracture were performed using independent-sample t-tests or Wilcoxon Mann-Whitney tests. Multivariable logistic regression was used to identify factors associated with stress fracture. To determine the association between stress fracture and postoperative outcomes, univariate logistic regression was performed with the presence of stress fracture as the independent variable. Significance was defined as p values less than 0.05.
Results
Stress fractures occurred in 8% (37 of 487) of patients and in 7% (40 of 608) of all hips. For patients who underwent bilateral PAOs, 11% (13 of 121) experienced a stress fracture following the second surgery. Bilateral stress fractures occurred in 2.5% (3 of 121) of patients.
Twenty-three hips (58% of fractures) had an isolated stress fracture of the posterior column, whereas 12 hips (30% of fractures) had isolated stress fracture of the inferior pubic ramus. Five hips (12% fractures) had stress fracture of both the posterior column and the pubic ramus.
Associations were found between stress fracture and increasing age (OR 1.05 [95% CI 1.01 to 1.09]; p = 0.03), higher body mass index (BMI) (OR 1.09 [95% CI 1.002 to 1.019]; p = 0.046), larger lateral center-edge angle correction (LCEA) (OR 1.05 [95% CI 1.01 to 1.1]; p = 0.02), nicotine use (OR 6.41 [95% CI 1.23 to 33.5]; p = 0.03), marijuana use (OR 3.06 [95% CI 1.18 to 7.96]; p = 0.03), and Ehlers Danlos syndrome (EDS)/hypermobility (OR 2.88 [95% CI 1.29 to 6.43]; p = 0.01). Although the proportion was higher, no difference was found between the risk of sustaining fractures after the first PAO and the second PAO in patients who underwent bilateral procedures (OR 2.0 [95% CI 0.96 to 4.19] p = 0.07). At most recent follow-up (mean time of 2.5 ± 2.0 and 3.0 ± 2.1 years; p = 0.22, for stress fracture and no stress fracture, respectively), patients with stress fractures had lower postoperative mHHS (79.2 ± 14.8 versus 86.5 ± 14.2; p = 0.003) and were less likely to meet the PASS (OR 0.39 [95% CI 0.14 to 0.72]; p = 0.03) or MCID (OR 0.44 [95% CI 0.18 to 1.07]; p = 0.049) for the mHHS. Patients with stress fractures had lower postoperative iHOT-12 scores (63.3 ± 23.9 versus 76.4 ± 22.8; p = 0.002) and smaller increases in improvement (30.3 ± 26.3 versus 46.8 ± 25.6; p = 0.003). Patients with stress fractures were also less likely to achieve the PASS for iHOT-12 (OR 0.31 [95% CI 0.14 to 0.72]; p = 0.003). No association was found between stress fracture and the preoperative mHHS (p = 0.60), postoperative mHHS (p = 0.10), achievement of MCID for iHOT-12 (p = 0.63), or subsequent surgery (p = 0.42).
Discussion
This study found that increasing age, higher BMI, larger LCEA correction, nicotine use, marijuana use, and EDS/hypermobility were associated with stress fracture following PAO. Furthermore, stress fractures were associated with generally worse PROMs at most recent follow up. As a result, surgeons and patients should consider these factors when deciding on treatment options for symptomatic acetabular dysplasia. An attempt to modify factors such as BMI, nicotine use, and marijuana use may be associated with reduced fracture risk, though the feasibility and timeline of such modifications must be weighed against individual patient circumstances. Patients with unmodifiable factors, such as increased age and EDS may be provided with more personalized postoperative protocols, such as increased non-weightbearing time, to decrease their risk of fracture. Conversations regarding slower improvements for patients with stress fractures may be warranted to establish aligned expectations between patient and provider. This study has several limitations. First, we investigated a limited number of variables associated with stress fracture. Second, nicotine and marijuana use may be underreported due to stigmatization of sharing this information with providers. Third, all patients were treated by a single surgeon at a tertiary referral center. Nevertheless, these findings support individualized risk assessment for patients considering PAO. Surgeons and patients should recognize that the decision to proceed with PAO involves multiple competing factors, including stress fracture risk.
Clinical Relevance
Stress fractures after PAO were associated with increasing age, higher BMI, larger LCEA correction, nicotine use, marijuana use, and EDS/hypermobility. Furthermore, they were associated with generally worse PROMs at most recent follow up. Surgeons should be aware of these associations when offering PAO to their patients in order to discuss potential lifestyle modifications, adequately establish patient expectations, and plan for individualized postoperative protocols when necessary.