

25 **Conclusion:**

26 Based on this case series, it appears that patients with stress fracture of proximal
27 tibia and concurrent gonarthrosis may be treated with primary TKA using
28 stemmed components that may bypass the stress fracture and allow healing of the
29 fracture.

30 **Keywords:**

31 Stress fracture, gonarthrosis, total knee arthroplasty

32 **Introduction**

33 The term "stress fracture" refers to the failure of the skeleton to withstand
34 submaximal forces over time (1). Stress fracture of the proximal tibia is a rare
35 disorder in elderly patients and has been reported to be associated with varus or
36 valgus gonarthrosis, rheumatoid-arthritis, osteoporosis, and Paget's disease (2-5,
37 6, 7, 8, and 9).

38 Treatment of stress fractures of the proximal tibia is challenging and the optimal
39 method remains controversial. Although protected weight bearing and analgesia is
40 the mainstay of treatment for stress fracture of proximal tibial in the young people
41 (10), patients with concurrent gonarthrosis and severe deformity may not respond
42 to non-operative treatment. Operative management of young patients with stress
43 fracture of proximal tibia may include intramedullary reaming to stimulate healing
44 (11). However, in the elderly patients, there is no consensus regarding the optimal
45 operative treatment. These patients, by the virtue of their age, may suffer from
46 severe knee osteoarthritis, and treatment of stress fractures in these patients may
47 need to take into account the presence of arthritis also (12). In addition
48 periarticular deformity in these patients and the increase forces at the knee may
49 compromise the healing of the stress fracture in these patients.

50 Surgical treatment of stress fractures of the proximal tibia in the elderly patients
51 with an arthritic knee includes internal fixation with second-stage total knee
52 arthroplasty (TKA) and one-stage TKA using long-stem tibial components (13).
53 Primary TKA is a recently introduced method that seems to be a reasonable
54 option for patients with severe osteoarthritis and stress fracture of the proximal
55 tibia. There is minimal data on the outcome of primary TKA using long stem tibia
56 component in these patients. The current study reports on the outcome of primary
57 TKA in series of elderly patients with concurrent stress fracture of proximal tibia
58 and arthritis of the knee.

59 **Methods**

60 Between 2009 and 2014, we performed TKA in 17 consecutive female patients
61 with proximal tibial stress fractures and concurrent arthritis. All patients were >
62 55 years old and suffered from severe degenerative changes in the knee joint due
63 to osteoarthritis (14 patients) or rheumatoid arthritis (3 patients). Diagnosis of
64 stress fractures was based on changes seen on radiographs, including sclerotic
65 areas that are often oriented linearly. Periosteal reaction or a cortical break may
66 also be present. If the x-rays were negative and did not explain the clinical
67 findings, bone scintigraphy was performed.

68 Standing alignment view was obtained for all patients and knee coronal alignment
69 (difference between mechanical axes of the tibia and femur), lateral distal femoral
70 angle (LDFA), and medial proximal tibial angle (MPTA) were measured. All
71 patients were operated on by the same surgeon. In 5 patients, Legacy constrained
72 condylar knees (Zimmer Company, USA) were used. For others, tibial stem
73 (Zimmer Company, USA) and gender femoral components (Zimmer Company,
74 USA) (7 patients) or LPS femoral components (Zimmer Company, USA) (5
75 patients) were used.

76 The joint was approached through a medial parapatellar arthrotomy. Bone cuts
77 and soft-tissue balancing were performed in the same sequence to correct
78 deformities. During tibial cut, In patients with complete fracture, fracture was
79 reduced and fixed by intramedullary tibial guide. If there was flexion and
80 extension gap mismatch, a more constrained prosthesis was used. Bone defects
81 were filled with cement, cement-screw or bone graft. Cement was placed only
82 under the tibial base plate and proximal part of the stem. A Long-stem tibial
83 component was required to bypass the fracture site by approximately two bone
84 diameters. Knee range of motion (ROM) and full weight bearing was started early
85 after the surgery.

86 Patients were revisited at 2 weeks and 1, 2, 3, 6, 9, 12 and 24 months
87 postoperatively. In follow up, union of the fracture site was investigated using
88 plain anteroposterior (AP) and lateral leg x-rays. Union was determined as
89 absence of pain at the fracture site and the presence of three bridging seen on
90 imaging in two orthogonal planes. Patients were asked about the pain and return
91 to the preoperative activity levels. Tegner activity scale was also recorded before
92 and after the operation to compare pre- and post-operative activity levels. The
93 orthopedic surgeon used a goniometer to measure knee ROM. The measurements
94 were repeated three times consecutively for each patient, and the data were
95 registered. The average of these three values was recorded as the ROM. To
96 investigate subjective outcomes, patients were asked about returning to their
97 previous job or sporting activity.

98 At the final visit, the overall Knee Society score (KSS) was completed for all
99 patients to determine the functional results of the surgery. Scores between 80 and
100 100 were graded as excellent, between 70 and 79 as good and between 60 and 69
101 as fair. Scores <60 were considered to be poor outcomes. Also, MPTA (Medial

102 Proximal Tibal Angle: an angle between anatomical axis of the tibia and tibial
103 articular line) was measured on the anteroposterior knee and leg x-rays and
104 compared with the preoperative MPTA. [Figure-1]

105 **Statistical Analysis**

106 Statistical analysis was performed using SPSS statistical software (version 15.0;
107 SPSS, Chicago, IL). Pre- and postoperative Tegner activity scales were compared
108 using Wilcoxon nonparametric test. Also, the pre- and post-operative MPTAs
109 were compared using a paired t-test. A P value of <0.001 was considered
110 statistically significant.

111 **Results**

112 One patient died during the follow up period and was excluded. The remaining 16
113 patients were aged 68.1 ± 7.2 years (ranges from 55 to 81 years). In 2 patients with
114 severe bilateral varus gonarthrosis, stress fractures occurred about one year after
115 conventional TKA of the contralateral limb. Clinical examination and plain
116 radiography were sufficient for diagnosis in 15 patients. In the last patient, x-rays
117 were normal and stress fracture was diagnosed using a bone scan. Preoperatively,
118 the mean varus angle of the fractured limb was 20.9 ± 1.7 degrees. The fracture site
119 was located at the metaphysodiaphyseal junction of the tibia in all patients. Four
120 patients had posteromedial defects of the proximal tibia >5 mm reconstructed
121 using corticocancellous allograft.

122 In the last visit, the mean overall KSS and Knee Society functional score were
123 86.4 ± 4 and 85 ± 6 , respectively, and graded as good or excellent in all patients.
124 Also, Tegner activity scale and MPTA improved significantly after the operation
125 [Table 1]. In one patient MPTA was 87 degree and in another patient MPTA was
126 88 degree, in two patients MPTA were 91 degrees and the mean MPTA was $90.3 \pm$
127 1.1 degrees postoperatively. The mean range of motion (ROM) of the knee was

128 118±2 degrees at final follow-up. In one patient ROM was 95 degree
129 postoperatively. Before surgery knee flexion of this patient was 90 degree. All
130 patients had union in at least three cortexes of the tibia. The mean time for union
131 was 8.3±1.1 weeks. The union time in one patient with rheumatoid arthritis as an
132 underline disorder was 6 months. No patient had pain in the leg except one who
133 had local tenderness in proximal medial of the leg, but she had radiologic union in
134 three cortexes of the tibia.

135 **Discussion**

136 The most important finding of the current study was that TKA can be used
137 effectively for treating proximal tibial stress fractures in elderly patients with knee
138 malalignment secondary to degenerative or rheumatoid arthritis.

139 Two forms of stress fracture have been defined fatigue and insufficiency fractures.
140 Fatigue fracture is classically found in military recruits and runners in whom
141 normal bone is exposed to repeat abnormal stresses (1). Insufficient fracture
142 happens when normal stress is applied to abnormal bone such as that in
143 osteoporosis.

144 The clinical presentation of stress fractures is insidious onset of pain without a
145 history of acute trauma. The hallmark physical finding is focal bone pain with
146 palpation, but findings vary depending on the location of the stress fracture and
147 the time from injury to presentation (14). Early x-rays of the stress fracture are
148 usually not helpful in demonstrating an abnormality. With the advancement of the
149 disease, however, radiographic changes can help visualize periosteal bone
150 formation, horizontal or oblique linear patterns of sclerosis and a frank fracture
151 line (15). When radiographic findings are conclusive, additional studies are not
152 required. If plain films do not support the presumptive diagnosis of stress fracture,
153 three-- phase bone scintigraphy is the study of choice (16).

154 Stress fracture of the proximal tibia is a rare disorder in elderly women and has
155 been reported be associated with varus or valgus gonarthrosis, rheumatoid
156 arthritis, osteoporosis, Paget disease and knee deformities (2-9, 17). However, due
157 to bone abnormalities in these patients, it is maybe better to categorize the stress
158 fracture as insufficient. In our study, patients suffered from severe varus
159 deformity (20.7 ± 1.7 degrees) and arthritic changes before the operation, which
160 resulted in insufficient stress fracture of the proximal tibial bone. In these patients,
161 varus gonarthrosis led to altered biomechanics and subsequently further stress and
162 strain on the tibial bone. Changes in mechanical axis of the limb in a severe varus
163 knee result in tension stresses on the convex side of the bone and compression
164 stresses on the concave side, leading to gradual weakening of the bone those
165 results in a stress fracture (18, 19).

166 Treatment of concomitant stress fracture and severe varus gonarthrosis is
167 complicated. Initial conservative treatment requires prolonged rest, with or
168 without cast or brace immobilization. Rest includes non-weight bearing
169 ambulation, wheelchair usage, avoidance of provocative activities, and
170 immobilization with or without electromagnetic stimulation (20, 21). However,
171 even over 4 to 6 months, many fractures with chronic changes and anterior cracks
172 will remain symptomatic and non-united. On the other hand, in patients with knee
173 osteoarthritis, prolonged immobilization results in knee stiffness and increased
174 knee pain (22).

175 Surgeries for these fractures include excision biopsy, drilling, excision and graft,
176 fixation of the fracture by plate and, more recently, intramedullary nailing (11, 23,
177 24). Plate fixation has some limitations because most patients have osteoporosis
178 and achieving stable fixation is therefore difficult. Furthermore prolonged non-
179 weight bearing leads to decreased bone density (25-26). Chang considered tibial

180 intramedullary nailing for treating these fractures of the tibia, but this procedure
181 can increase the risk of anterior knee pain in these patients (27, 28, and 29).
182 Additionally, late TKA with a tibial plate or intramedullary nail is difficult or
183 impossible.

184 Regarding the complications of operative or nonoperative treatments, some
185 authors suggested TKA for treating proximal tibial stress fractures in elderly
186 patients with severe degenerative changes. However, a limited numbers of reports
187 have investigated the outcomes of such a treatment in this patient population.
188 Sawant et al described the results of one- stage TKA using a long -stem tibial
189 component for treatment of proximal tibial stress fractures in an arthritic knee
190 with valgus deformity in 4 patients. Healing and acceptable outcomes occurred in
191 all patients in their study (30). It seems that long- stem TKA for correction of
192 varus and/valgus deformities can alter tension stresses to the compression stresses
193 at the fracture site (18). In the largest case series regarding the treatment of
194 periarticular stress fractures in patients with gonarthrosis, Mittal et al found good
195 outcomes in 31 knees (26 varus and 5 valgus) with tibiofemoral stress fractures
196 after TKA. In this case series there were 5 patients with intraarticular stress
197 fractures of the tibia that resulted in medial defects of the proximal tibia. The
198 authors reported that all fractures had united without any complications (13).
199 We studied 16 women with tibial stress fractures at the metphysodiaphyseal
200 junction of the tibia in arthritic knees. All patients had varus deformity and were
201 operated on using the same manner to correct deformities. After one-stage long-
202 stem TKA, complete union was obtained in all patients, without additional
203 approaches to the leg for treating the stress fracture. The mean time to union was
204 8.3 ± 1.1 weeks. The mean MPTA improved significantly and reached 90.3 ± 1.1
205 degrees at the last follow-up which is an optimal outcome. In two patients there

206 were mild varus (one patient had 3 degree varus and another patient had 2 degree
207 varus deformity postoperatively) deformity postoperatively because of indirect
208 reduction of the fracture in these patients. Two years postoperatively, good
209 alignment was maintained in our patients. Functional outcomes as measured by
210 KSS and Tegner activity scale were considerably satisfactory. Tegner activity
211 scale improved significantly. Also, overall KSS and Knee Society function score
212 were graded as good or excellent in all of the patients.

213 Similar to other studies, there are some limitations to our study which was a
214 descriptive one with a limited number of patients.

215 **Conclusions:**

216 Based on our study, long- stem TKA is a good option for treatment of proximal
217 tibial stress fractures in elderly patients with degenerative changes of the knee. It
218 allows simultaneous treatment of knee arthritis and stress fracture and maintains
219 good alignment of the tibia. TKA was associated with satisfactory clinical,
220 radiological and functional outcomes without any complications. The authors
221 recommend using this treatment option for degenerative knees with proximal
222 tibial stress fractures; however, further prospective long-term studies with more
223 patients are required.

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291 patients with deformed arthritic knees. *J Bone Joint Surg Br.*(1999); 81-B(4): 663-6.

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293 **Figure 1.** A 72 years old woman with severe osteoarthritis and proximal tibia stress
294 fracture (A. Anteroposterior view. B. Lateral view. C. Standing alignment view.)
295 treated with total knee arthroplasty with a long tibial stem. (D. Anteroposterior and
296 lateral views). Radiographs of the prosthesis two years after replacement of the
297 proximal tibia (E. Anteroposterior view). **In this patient there was 3 degree varus**
298 **deformity in the fracture site and MPTA (Medial Proximal Tibial Angle: an angle**
299 **between tibial anatomical axis and tibial articular line) was 87 degree.**

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