



Anterior Tibial Tuberosity Osteotomy in Patellar Instability: There are No Differences in Functional Clinical Outcomes or Bone Healing between Fixation with One 6.5-mm Screw and Two 4-mm Screws

Osteotomía de la tuberosidad anterior de la tibia en inestabilidad patelar: No hay diferencias en resultados clínicos funcionales o consolidación entre una fijación con 1 tornillo de 6,5 mm y 2 tornillos de 4 mm

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Abstract

Introduction Anterior tibial tuberosity (ATT) osteotomies can be fixed with one or more screws. Nevertheless, limited evidence is available regarding the optimal number of screws.

Objective To compare the functional and radiographic outcomes and complications of patients who underwent ATT osteotomy fixed with one 6.5-mm or two 4-mm screws. Our hypothesis is that fixation of the ATT with two 4mm screws yields better functional and radiological outcomes and fewer complications.

Materials and Methods We conducted a retrospective, multicentric study including 30 patients who underwent ATT osteotomy fixation with one 6.5-mm cancellous screw (group 1; n = 15) or two 4-mm cancellous screws (group 2; n = 15) with a minimum follow-up of 2 years. We excluded patients who underwent medial patellofemoral ligament reconstruction and those with inflammatory or severe degenerative knee disease. Clinical and radiological data, as well as complications, were recorded. The functional outcomes were assessed through Lysholm and Kujala scales and bone healing, through the Cornu scale. In the statistical analysis, values of $p < 0.05$ were

Keywords

- ▶ patellofemoral instability
- ▶ anterior tibial tubercle osteotomy
- ▶ fixation
- ▶ screws
- ▶ bone healing

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deemed significant, and grade 1 on the Cornu scale was considered the parameter for bone healing.

Results As for the functional results, on the Lysholm scale, group 1 presented a median score of 78 (range: 23–95) points, and group 2, a median of 81 (range: 25–100) points ($p = 0.632$); On the Kujala scale, group 1 presented a median score of 79 (range: 38–97) points, and group 2, a median of 80 (range: 39–100) points ($p = 0.819$). The median time until bone healing was of 2 months in both groups ($p = 0.694$). Regarding complications, one case of delayed union and one case of symptomatic hardware removal were observed in each group.

Conclusion No clinical and radiographical differences were observed between the fixation of ATT osteotomies with one 6.5-mm or two 4-mm screws.

Level of evidence IV.

Resumen

Introducción Osteotomías de la tuberosidad anterior de la tibia (TAT) pueden fijarse con uno o más tornillos; no obstante, existe limitada evidencia sobre el número idóneo de tornillos.

Objetivo Comparar los resultados funcionales, radiológicos y las complicaciones de pacientes sometidos a osteotomías de la TAT fijadas con 1 tornillo de 6,5 mm y con 2 tornillos de 4 mm. Nuestra hipótesis es la de que, con la fijación de la TAT con 2 tornillos de 4 mm, se logran mejores resultados funcionales y radiológicos y menos complicaciones.

Materiales y Métodos Estudio retrospectivo, multicéntrico, con 30 pacientes sometidos a osteotomía de la TAT fijada con 1 tornillo de esponjosa de 6,5 mm (grupo 1; $n = 15$) o 2 tornillos de esponjosa de 4 mm (grupo 2; $n = 15$), con mínimo de 2 años de seguimiento. Se excluyeron pacientes sometidos a reconstrucción del ligamento patelofemoral medial, y aquellos con enfermedad inflamatoria o degenerativa avanzada de rodilla. Se registraron datos clínicos, radiológicos y complicaciones. Se utilizaron las escalas de Lysholm y de Kujala para la evaluación funcional, y la de Cornu, para la consolidación. En el análisis estadístico, valores de $p < 0,05$ fueron considerados significativos, y se consideró grado 1 en la escala de Cornu como parámetro de consolidación ósea.

Resultados Respecto a los resultados funcionales, en la escala de Lysholm, la mediana del puntaje en el grupo 1 fue de 78 (rango: 23–95), y en el grupo 2, de 81 (rango: 25–100) ($p = 0,632$); y en la escala de Kujala, la mediana en el grupo 1 fue de 79 (rango: 38–97) puntos, y en el grupo 2, de 80 (rango: 39–100) puntos ($p = 0,819$). La mediana del tiempo hasta la consolidación ósea en ambos grupos fue de 2 meses ($p = 0,694$). Respecto a las complicaciones, se observó un caso de retraso de unión y un caso de retirada sintomática del dispositivo en cada grupo.

Conclusión No se encontraron diferencias clínicas ni radiológicas significativas entre fijar las osteotomías de la TAT con 1 tornillo de 6,5 mm o 2 tornillos de 4 mm.

Nivel de Evidencia IV.

Palabras clave

- ▶ inestabilidad patelofemoral
- ▶ osteotomía del tubérculo tibial anterior
- ▶ fijación
- ▶ tornillos
- ▶ consolidación ósea

Introduction

Osteotomy of the anterior tibial tuberosity (ATT) is indicated in patients with recurrent patellar instability associated with *patella alta*, lateralized ATT (high Q angle) or lateral patellofemoral osteoarthritis.¹ It involves transferring the ATT anteriorly, medially, distally, or a combination thereof, depending on the patient's symptoms and the bone anatomy alteration to correct.²

Medialization of the ATT aims to reduce the lateral vector exerted by the distal extensor mechanism on the patella.² Among the medialization procedures,³ the Elmslie-Trillat, Maquet, and Fulkerson techniques, as well as combinations of these, stand out.⁴ Osteotomy of the ATT is often combined with patellar stabilization procedures, such as reconstruction of the medial patellofemoral ligament (RMPFL), and lateral retinacular lengthening or release. Less frequently, it is associated with varizing or derotation osteotomies of the

femur or tibia, following the principle of “à la carte surgery” (focused on correcting factors predisposing to recurrent patellar instability).^{5,6}

The primary goal of ATT transfers in the context of lateral patellar instability is to correct predisposing malalignment. This involves performing a medialization osteotomy of the tuberosity, which can be accompanied by advancement (anteriorization) or distalization as needed. Regardless of the chosen technique, fixation of the ATT is crucial to ensure consolidation of the osteotomy and the success of the procedure.

The ATT osteotomy can be fixed through one or more screws, plates or with wire cerclage, with screw fixation being the most reproduced, due to its biomechanical advantage over cerclage, lower cost, and lower risk of symptomatic osteosynthesis regarding the plates.⁷ However, there is controversy and little evidence regarding the number and diameter of screws that should be used to ensure a stable transfer.⁸ Using a single screw results in lower cost and shorter surgical time, but also in a greater theoretical risk of rotation and more bone resorption if accompanied by advances in ATT.^{9,10}

The objective of the present work is to compare the clinical and radiological outcomes of patients undergoing ATT realignment osteotomies through the Elmslie-Trillat technique fixed with one 6.5-mm screw versus two 4-mm screws. The hypothesis is that fixation with two 4-mm screws presents better functional and radiological outcomes and a lower complication rate than fixation with one 6.5-mm screw.

Materials and Methods

The present is a retrospective, multicenter study conducted at two healthcare centers in the Metropolitan Region of Santiago, Chile. The study was approved by the institutional Ethics Committee.

We included patients operated on by three surgeons from the same surgical team from 2003 to 2008 with a diagnosis of recurrent patellar dislocation supported by radiographs and computed tomography (CT) scans indicating patellar malalignment syndrome, with a distance between the ATT and the center of the trochlear groove (ATT-TG) greater than 20 mm. All patients had a minimum follow-up of 2 years. We excluded patients undergoing RMPFL, trochleoplasty, or femoral axis corrective osteotomies, as well as those with advanced degenerative or inflammatory knee conditions.

In all cases, medialization of the ATT was performed using the Elmslie-Trillat technique, fixated with either one 6.5-mm

screw (group 1) or two 4-mm screws (group 2). The choice of the number of screws followed institutional protocol: one center always used two 4-mm screws, while the other always used one 6.5-mm screw. Out of a total of 60 patients (27 in group 1 and 33 in group 2), 19 were excluded due to concurrent RMPFL during ATT osteotomy (5 in group 1 and 14 in group 2), and 9, due to advanced degenerative or inflammatory knee pathology (5 in group 1 and 4 in group 2). We randomly selected 15 patients for group 1 to match group 2. ► **Table 1** summarizes the demographic data and radiological parameters of both groups, which were equivalent in terms of age, gender, and ATT-TG.

After obtaining the imaging studies with X-rays and CT scans, the surgical treatment to be performed was defined: if the patient had an ATT-TG > 20 mm, medialization of the ATT was performed. If the patient had signs of chondromalacia, ATT advancement was added. There were no cases of patellar descent in the present case series.

Surgical Technique

First Stage: Arthroscopic

In all cases, surgery was performed with the patient in supine position on a radiolucent table, with the limb under tourniquet throughout the procedure.

The procedure began with diagnostic arthroscopy through standard anteromedial and anterolateral portals to assess the presence chondral lesions resulting from instability. None of the patients required specific treatment for chondral lesions beyond focal thermal chondroplasty.

Second Stage: Open

Anatomical landmarks were marked for the surgical incision: distal patellar pole, ATT, and patellar tendon. A longitudinal incision of 4 cm was made, 1 cm lateral to the midline of the ATT, starting from the insertion of the patellar tendon into the ATT distally (► **Image 1**). Dissection was carried out layer by layer until the ATT was identified, with the lateral margin released using electrocautery. The patellar tendon was identified and protected.

Osteotomy: The tuberosity was marked 5 cm distal to the insertion of the patellar tendon, and, at this point, using a 2-mm drill bit, 5 to 6 perforations were made in the anterior tibial cortex, parallel to each other and perpendicular to the axis of the tibia. This was performed to reduce the distal resistance of the ATT without fracturing it, achieving a hinge effect that facilitates medialization and has been shown to promote osteotomy union rates while reducing the risk of tibial fracture.¹¹ Longitudinal osteotomy of the ATT was

Table 1 Demographics and radiological parameter of patients according to study group

	Group 1: one 6.5-mm screw (n = 15)	Group 2: two 4-mm screws (n = 15)	p
Age: median (range)	32 (16–48)	31 (16–46)	0.967
Female gender: n (%)	12 (80%)	13 (87%)	0.999
ATT-TG (mm): median (range)	22.4 (20.3–25.4)	23 (20.1–26.1)	0.971

Abbreviation: ATT-TG, distance between the anterior tibial tuberosity and the center of the trochlear groove.

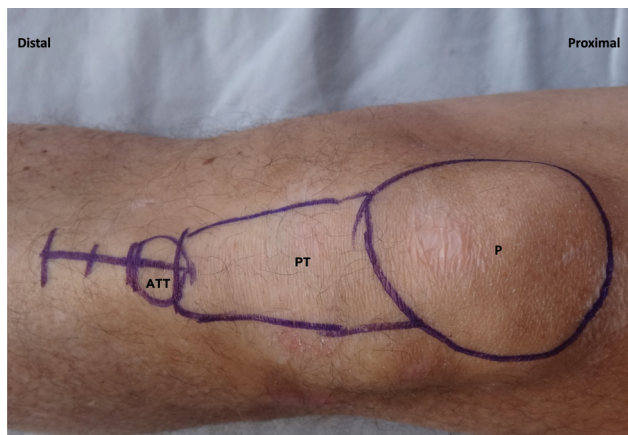


Image 1 Surface anatomical landmarks to approach anterior tibial tuberosity (ATT) osteotomy are delineated from proximal to distal on a left knee: the patella (P), patellar tendon (PT), and the ATT. The longitudinal incision measures approximately 4 to 6 cm, starting from the insertion of the PT on the ATT and extending distally.

performed with a blade osteotome, in a plane coronal to the tibial axis, leaving a fragment of approximately 10 to 15 mm thick (**Image 2**). Once the osteotomy was completed, the ATT was standardly medialized by 10 mm. A 2-mm Kirschner wire was placed in the tibial metaphysis, temporarily, directly lateral to the already medialized ATT, with the aim of avoiding relateralization of the fragment (**Image 3**).

In cases in which advancement was indicated, a structured autograft in the form of a wedge was taken from the Gerdy tubercle, previously exposed through the same incision. This graft was placed posteriorly to the already medialized ATT, achieving a 10-mm advancement in all cases.

Once the axes were corrected, the ATT was fixed with one or two partially threaded cancellous screws to achieve compression fixation. In all procedures, the fixation was supplemented with a temporary 2-mm Kirschner wire (in-

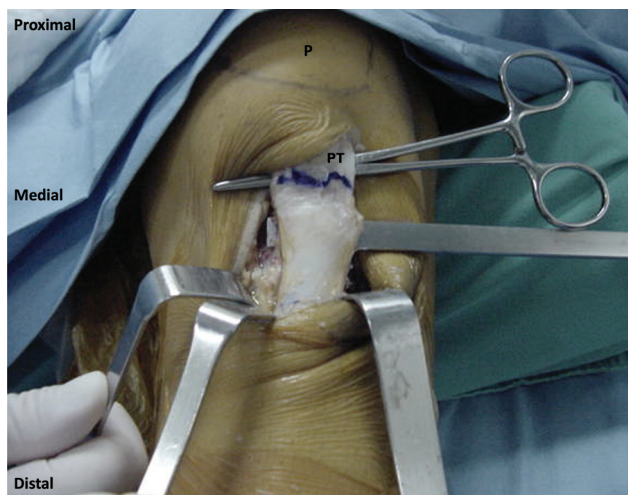


Image 2 Longitudinal ATT osteotomy of a left knee. An osteotomy is performed in the coronal plane of the tibia behind the anterior tibial tuberosity with a thickness of approximately 10 to 15 mm. The distal boundary of the PT is clearly marked and protected to prevent damage. **Abbreviation:** P, patella.



Image 3 Medialization of ATT of a left knee. The ATT is medialized by 10 mm. A temporary 2-mm Kirschner wire is placed in the tibial metaphysis, directly lateral to the medialized ATT, to prevent loss of medialization of the osteotomy in its new position until definitive fixation is performed. The distal boundary of the PT is clearly marked.

dependent of the one used to maintain lateralization), which traversed the osteotomy fragment to prevent rotation during screw fixation.

Group 1—Fixation with one 6.5-mm screw: Osteosynthesis was performed at the center of the medialized ATT, drilling with a 3.2-mm drill bit that included the posterior cortex of the tibia. The length of the drilling was measured, the canal was tapped, the anterior cortex was countersunk, and fixation was achieved with a 32-mm cancellous screw (with 6.5 mm in diameter), compressing the osteotomy site (**Image 4A**). A washer was used in cases in which bone strength was subjectively considered suboptimal by the surgeon.

Group 2—Fixation with two 4-mm screws: Osteosynthesis of the ATT was performed with 2 small-fragment cancellous screws (4 mm), one located 20 mm and the other, 40 mm distal to the insertion of the patellar tendon, drilling the ATT with a 2.5-mm drill bit, including the posterior tibial cortex (**Image 4B**). A first cancellous screw with a 32-mm thread was placed to achieve interfragmentary compression of the ATT, and a second with a full thread to increase the strength of the fixation. A washer was used in cases in which bone strength was subjectively considered suboptimal by the surgeon during the surgical procedure.

After fixing the ATT with one or two screws, correct reduction and osteosynthesis of the fragments were confirmed under fluoroscopic guidance, and any discrepancies were corrected. Subsequently, the tourniquet was released, hemostasis was achieved, and the layers were closed. The skin was sutured with intradermal stitches and sterile patches were applied. A knee joint splint was applied in a range of 0° to 30° of flexion in all patients.

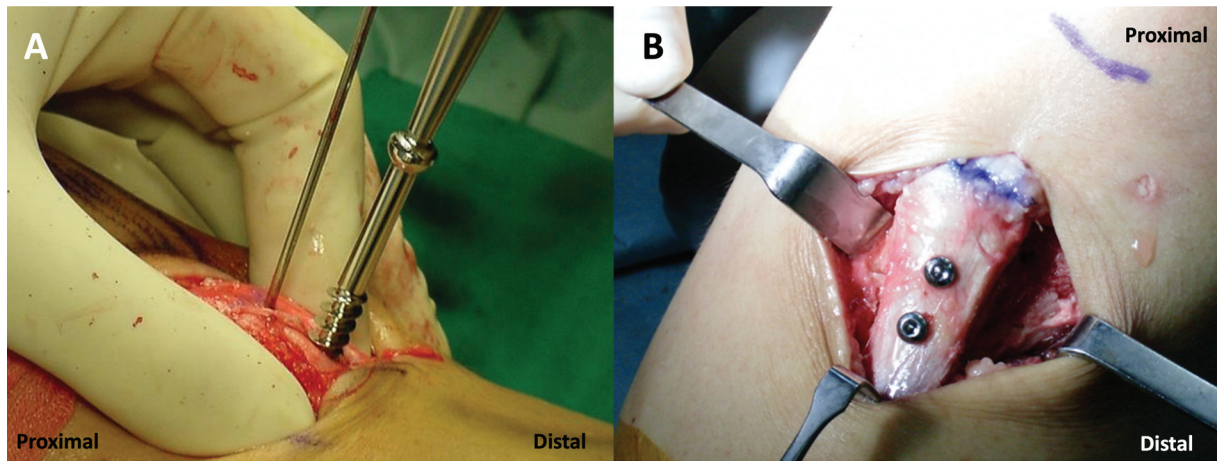


Image 4 Fixation of the ATT with one 6.5-mm screw or two 4-mm screws in left knees. The fixation of the ATT can be performed using a 6.5-mm large fragment cancellous screw with a 32-mm thread length, positioned at the center of the osteotomy (A), or using 2 small fragment cancellous screws (4 mm), approximately 20 mm and 40 mm distal to the insertion of the PT marked in blue (B).

Postoperative Management and Rehabilitation

Immediate postoperative care involved pain management with intravenous analgesics, cryotherapy, and active ankle and hip exercises within the first 24 hours. Antibiotic prophylaxis was administered for 24 to 48 hours, and thromboprophylaxis was administered for the first 10 days postoperatively, depending on the presence of thromboembolic risk factors for each case.

Patients were allowed partial weight-bearing with 2 crutches according to pain tolerance, using the knee joint splint allowing a range of 0° to 30° of flexion for the first 2 weeks, increasing by 30° every 2 weeks. Progressive weight-bearing up to 100% was authorized during the first 2 to 3 weeks depending on the patient's symptoms, always with the knee splint in place.

Rehabilitation with a physiotherapist began in the first postoperative week, including physical therapy, isometric quadriceps exercises from the first rehabilitation session, and progressive passive range of motion exercises up to 90° in the first month, followed by full range of motion exercises in the subsequent 4 weeks. Aerobic exercises involving the limb started at 4 weeks postoperatively. Active strengthening exercises commenced once inflammation and pain were controlled, typically around 6 to 8 weeks after surgery.

The sport-specific rehabilitation phase began at 12 weeks in those patients who practiced sports, and the return to sport was carried out once radiological and clinical consolidation was confirmed after 4 months and depending on the degree of muscular rehabilitation at that time, usually after the sixth month.

All patients were monitored every 4 weeks with radiographs to evaluate the consolidation of the osteotomy, until radiological consolidation of the ATT was completed.

Measurement of Functional Clinical Outcomes

The functionality of the operated patients was assessed by recording the scores on the scales by Lysholm¹² and Kujala et al.¹³ in clinical records, with at least 2 years of follow-up since the operation.

Bone Consolidation Measurement

The time required to achieve ATT union was considered by evaluating consecutive postoperative radiographs of all patients. To determine bone consolidation, we used the category of the Cornu¹⁰ scale that evaluates the fusion of the ATT osteotomy and is based on the visualization or absence of the osteotomy line, dividing it into three grades: grade 0—unconsolidated or still visible fusion line; grade 1—partially-visible fusion line; and grade 2—fusion line not visible. For the present study, grade 1 (initial radiographic fusion) was considered a measure of consolidation accompanied by favorable clinical progression, a necessary parameter to allow weight-bearing, full range of motion exercises, and concentric exercises in all patients.

Complication Measurement

The descriptions in the operating protocol and in the immediate postoperative radiograph were analyzed for the presence of intraoperative complications such as: fracture of the tibial tuberosity, insufficient fixation of the osteosynthesis, and loss of advancement due to excessive compression of the screw or insufficient medialization of the ATT. We analyzed the description in the clinical record, the postoperative radiographs, and the presence of new surgical protocols in search of postoperative complications such as: problems in closing the surgical wound, infections, neurovascular lesions, thromboembolic disease, arthrofibrosis that required surgery, symptomatic osteosynthesis, displacement or failure of the osteosynthesis, and non-union of the ATT osteotomy. Non-union was considered the absence of bone consolidation that required a revision procedure, and delayed consolidation, the absence of consolidation after 3 months that resolved without the need for surgical intervention.¹⁴

Statistical Analysis

A power analysis was conducted to calculate the sample size, which considered an expected mean difference of 10 points in the Lysholm¹² scale between the compared groups, which corresponds to the minimal clinically important difference

Table 2 Functional and radiological clinical outcomes

	Group 1: one 6.5-mm screw (n = 15)	Group 2: two 4-mm screws (n = 15)	p
Score on the Lysholm ¹² scale: median (range)	78 (23–95)	81 (25–100)	0.632
Score on the Kujala et al. ¹³ scale: median (range)	79 (38–97)	80 (39–100)	0.819

(MCID),¹⁵ and a standard deviation of 9 points according to the dispersion found in the local population,¹⁶ with a significance of 5% and a statistical power of 80%. The result of the analysis indicated a minimum number of 13 knees per group. We included 15 knees per group, since it was the maximum found for patients undergoing an isolated osteotomy of the ATT fixated with two 4-mm screws.

The Mann-Whitney test was used to compare medians, the Fisher exact test was used for the categorical variables, and Cox proportional model regression, for the association between the time to achieve Cornu¹⁰ grade 1 consolidation and the number of screws used. Values of $p < 0.05$ were deemed statistically significant.

The data were tabulated in the Microsoft Excel (Microsoft Corp., Redmond, WA, United States) software, version 16.64, and analyzed with the Stata software (StataCorp LLC, College Station, TX, United States), version 14.1.

Results

The median follow-up time to record the functional tests was of 2.8 (range: 2–4.3) years for the group with ATT fixed with one 6.5-mm screw, and of 3 (range: 2–4) years in the group

with fixation with two 4-mm screws. There were no significant differences between the groups ($p = 0.647$).

Functional Clinical Results

► **Table 2** summarizes the functional clinical results found. There were no significant differences between the groups for the median scores on the Lysholm¹² ($p = 0.632$) and Kujala et al.¹³ ($p = 0.819$) scales.

Time to Bone Consolidation

► **Image 5** shows the distribution of patients according to the time to achieve radiological bone union (Cornu¹⁰ grade 1). The mean time to consolidation was of 2 months in both groups, with no significant differences between them ($p = 0.694$). Neither did the regressive analysis show a significant association between the time until union and the number of screws used for fixation of the ATT ($p = 0.682$).

Complications

No intraoperative complications were observed in any of the groups. Regarding postoperative complications, there were two cases of delayed union (one in each group), two cases of symptomatic removal of the osteosynthesis material (one in

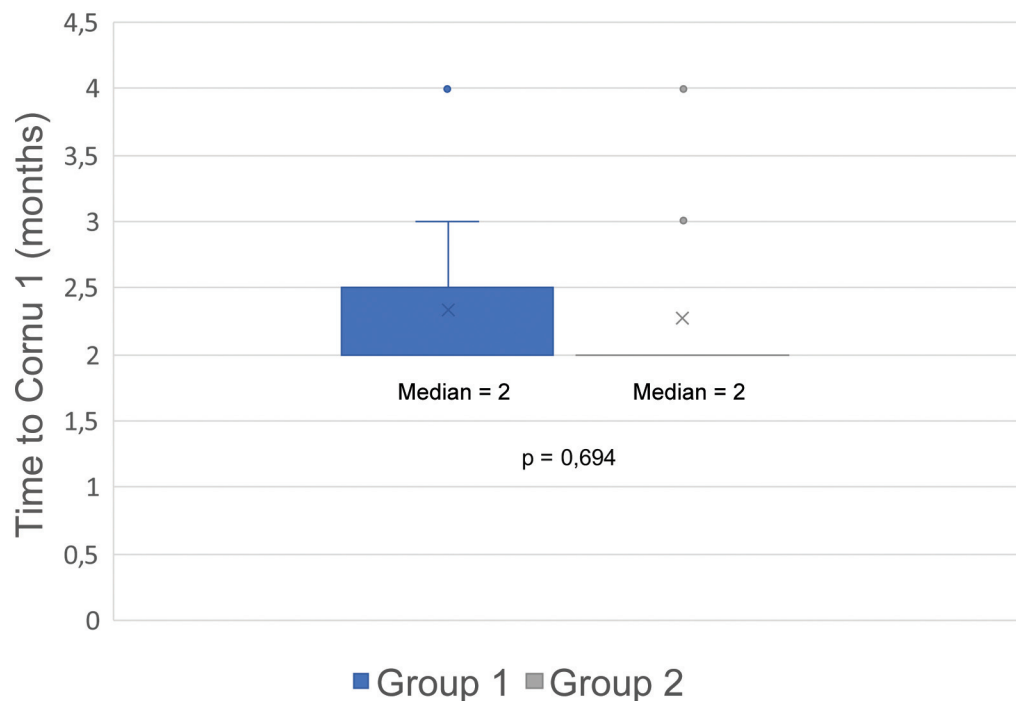


Image 5 Time to achieve radiographic bone consolidation (Cornu¹⁰ grade 1). The boxplot graph shows the distribution of patients according to study group regarding the time to achieve radiographic bone consolidation defined as Cornu¹⁰ grade 1. Both groups had a median of 2 months, with a range from 2 to 4 months. The mean for the group with the ATT fixated with one 6.5-mm screw was of 2.33 months, and for the group with the ATT fixated with two 4-mm screws was of 2.26 months.

each group), and one case of partial wound dehiscence with secondary intention closure (in the group fixated with a 6.5-mm screw), with no significant differences ($p=0.99$) between the groups. There were no cases of infections, neurovascular injuries, thromboembolic events, arthrofibrosis requiring surgery, osteotomy displacement, osteosynthesis failure, or non-union of the osteotomy.

Discussion

The most relevant result of the present study is that no significant clinical or radiological differences were found between fixation of the ATT with one 6.5-mm screw or two 4.0-mm screws.

From a theoretical point of view, mechanically fixation with a large fragment screw would achieve greater compression as it has a larger diameter; however, it would increase the risk of rotation of a fragment or bone fracture that is to be fixed.⁹ Although two screws would significantly decrease the risk of rotation of the screw, we propose that they would result in an increased risk of longitudinally fracturing the ATT fragment. Despite the theoretical risk of rotational displacement of the fragment when using single-screw fixation, rotation in the ATT was not observed during surgery in the group with a 6.5-mm screw, because the fixation was complemented with a transitory Kirschner wire. No fractures of the fragment or tibia were observed in the group with 2 screws, which differs from the 5% of tibial fractures reported by Lundeen et al.¹⁴ using two 3.5-mm screws. The evidence on measures to prevent tibial fractures is limited, and no specific studies were found that report on the distance between screws. We recommend a separation of at least 20 mm between the screws.

On the other hand, it has been described that larger screws present a significantly greater risk of generating symptomatic osteosynthesis and, consequently, also a greater number of secondary procedures for their removal.⁸ Descriptive studies have reported a symptomatic osteosynthesis removal rate of 16% with 3.5-mm screws,¹⁷ of 30% with 4-mm screws,¹⁸ and of 52% with 4.5-mm screws.^{19–21} In a comparative retrospective series, Johnson et al.⁸ demonstrated that fixations with three 3.5-mm screws yielded a significantly lower rate of symptomatic osteosynthesis and removals than fixations with two 4.5-mm screws (2.6% versus 27% respectively). It has been reported that 6.5-mm screws are frequently removed.^{8,22} However, the study by Endres and Wilke,²² in which the osteosynthesis was removed in at least 72% of the cases, was the only published study found that describes the removal rate when using 6.5-mm screws. In the current study series, using a 6.5-mm screw, there was only 1 case (6.6%) requiring symptomatic removal of the osteosynthesis, similar to the group using 2 screws (6.6%). In contrast to the study by Endres and Wilke,²² in which the ATT was fixed with two 6.5-mm screws, in the present study, we fixated the ATT with a single 6.5-mm screw, resulting in less local irritation.⁸ On the other hand, possibly this same reason would explain why the group with 4-mm screws in the present study showed a low rate of

osteosynthesis removal (6.6%), since 2 screws were used instead of 3.¹⁸

Regarding radiographic consolidation, although a greater number of patients achieved consolidation in a shorter time in the group with two 4.0-mm screws, the medians were equal, and no significant differences were demonstrated between the groups. Neither did the regression statistical analysis show an association between the number of screws used and the time to achieve bone consolidation. In the comparative study by Johnson et al.,⁸ mentioned earlier, no significant differences were observed between the groups; however, there was a lower rate of delayed consolidation in the group fixated with three 3.5-mm screws (11%) compared to the group fixated with two 4.5-mm screws (27%). Further studies with a larger number of patients and focused directly on bone consolidation and the number and size of screws used for ATT fixation are needed to validate these observations. Another aspect that could influence the consolidation of ATT osteotomy fixated with screws is their orientation. While in the present study all screws were placed parallel to each other, Aykanat et al.²³ recently demonstrated, in a finite element analysis, that a configuration of divergent screws could be favorable for bone consolidation. Future clinical studies may contribute to elucidate this evidence.

In terms of complications, there was one removal of symptomatic osteosynthesis material in each group and only one case of superficial wound dehiscence, without exposure of osteosynthesis, in a patient fixated with a screw that closed by secondary intention. This minor complication was not significant to conclude that the one-screw group presented more complications than the group with two screws. Furthermore, there were no major complications in the studied groups (such as tibial fracture, deep venous thrombosis or non-union), which is consistent with what was reported in the literature by Johnson et al.,⁸ in a multicenter series of 240 patients, who described a rate of $\leq 3\%$ of these major complications, and by van Sambeek et al.,²⁴ with incidences of nonunion of 0.6% and tibial fractures of 0.4% in 529 osteotomies performed. These figures differ from those recently published by Lundeen et al.,¹⁴ who reported a high rate of major complications of up to 21.5% in 163 ATT osteotomies. However, of the total of these major complications reported in their series, 50% corresponded to arthrofibrosis that required surgery, which was also higher than the 2.8% reported in the literature.²⁰ The differences reported may be due to the moment in which the need to perform a procedure to treat arthrofibrosis is established, which varies in the literature and should be reserved for those cases refractory to conservative treatment.²⁵ Excluding arthrofibrosis and considering only the subgroup from Lundeen et al.¹⁴ compared to the present study, in which the ATT was not distalized (66 patients), the rate of major complications reported decreases to 12.1%, with fractures of the tibia, osteosynthesis failure, delayed consolidation specifically of $\leq 3\%$, and no reports of non-unions.

To the authors' knowledge, this is the first study to evaluate clinical and radiological differences between TAT

transfer fixation with one 6.5 mm screw versus two 4 mm screws. Functional scales validated in the literature for knee pathology were used²⁶ and specifically for patellofemoral pathology.¹³ However, the study is not without limitations. Firstly, the results stem from a retrospective series with all the biases that this entails. In particular, demographic data that could have affected bone consolidation and postoperative functional outcomes, such as smoking habits, comorbidities, and medication use could not be included. Secondly, although a larger number of patients than indicated by the statistical power test was used to achieve 80% of power, and a similar number of patients as described in the literature was gathered,^{18,27} there is a limited number of patients in each group to extrapolate the results globally, particularly for major complications (fractures, infections, surgical wound complications, deep venous thrombosis, symptomatic non-union), which have been reported in rates ranging from 3% to 21.5%.^{14,28,29} It is important to mention that strict selection criteria were used; in particular, the authors are aware of what is recommended in the consensus, that RMPFL is the fundamental pillar in the treatment of patellar instability,^{5,6,30} we decided to exclude patients undergoing RMPFL, trochleoplasties or other osteotomies in order to reduce other variables that could have affected the results of the study. Third, although the Cornu¹⁰ classification was considered, which has not been specifically validated for bone healing, it is the only classification found that specifically evaluates bone fusion of an ATT osteotomy. Most of the studies reviewed do not mention how they determined bone consolidation^{14,24} or use methods described for other anatomical sites.⁸ Finally, being a multicenter study, there is a possibility that patients from different institutions may interpret postoperative instructions differently, which could affect their functionality. However, all patients were operated on by surgeons from the same surgical team, who standardized postoperative instructions at both centers.

The present study explores the feasibility of fixing an ATT osteotomy with a 6.5-mm screw, achieving comparable results without significant differences compared to using two 4-mm screws. This highlights this fixation method as a valid option, with the economic and technical advantages it entails. Considering the limited evidence regarding the number and diameter of screws needed for ATT osteotomy fixation, there is a need for prospective studies with a larger number of patients to clarify if there is an ideal number and diameter of screws for osteosynthesis in these cases.

Conclusion

No significant clinical or radiological differences were found between fixing the ATT osteotomies with one 6.5-mm screw or two 4-mm screws.

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Conflict of Interests

The authors have no conflict of interests to declare.

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