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Original Article

Breakage and Migration of Metal Wires in Operated Patella Fractures: Does it Correlate with Time?

髕骨骨折內固定的術後鋼絲斷裂和遷移與術後時間長度有關聯嗎？

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ABSTRACT

Background: Tension-band wiring with metal wires is a commonly used technique to treat transverse patella fractures. Wire breakage and migration may potentially cause complications or morbidities such as nerve irritation or skin impingement. The need of extra wound or surgery for implant removal may be required. We hypothesize that the breakage of patellar tension-band wires is related to the patient's age and the length of time after fracture fixation.
Methods: We retrieved and analysed our 11 years records (from January 1, 2000, to May 31, 2011). The inclusion criteria were: (1) patients with transverse patella fracture treated with tension-band plus cerclage wiring technique, (2) with their metal wires removed in our hospital, (3) unilateral patella fracture, (4) wire removal not due to infection, (5) wire removal after complete fracture union, (6) no fracture distal pole or partial patellectomy with protective wire loop, and (7) known exact date of the initial fracture fixation surgery. We reviewed the reasons of wire removal, the presence of broken or migrated wires upon implant removal, and the time lapse from fracture fixation to removal of wire.
Results: A total of 59 cases were recruited and studied. A total of 28 patients had intact wires and 31 patients had broken wires upon implant removal. For the age of patients at fracture fixation, there was no statistically significant difference between the intact wire group and the broken wire group. However, for the length of time from fracture fixation to implant removal, the difference was statistically significant between the two groups of patients. It suggested that the risk of wire breakage increases with time after patellar tension-band wiring. If 12 months was used as a cut-off time, there was a statistically significant association between the duration from fracture fixation to implant removal and the presence of broken wire. There were seven cases of wire migration among the 31 patients with broken wires, and two of them needed an extra open wound at popliteal fossa for implant removal.
Conclusions: The risk of patellar tension-band wire breakage was associated with increase time lapse from fracture fixation, but not the patients' age upon fracture fixation. The risk of wire breakage significantly increases after 12 months from the fracture fixation. Wire breakage can lead to further morbidities or complications. Routine removal of wire loops may be indicated. Future prospective longitudinal long-term studies may be required.

中 文 摘 要

背景: 張力帶鋼絲內固定是一種常用的髕骨橫行骨折治療技術。鋼絲斷裂和遷移有可能引致併發症或病況，例如刺激神經線或皮膚衝擊，需要額外的創口或手術以取出植入物。我們假設髕骨張力帶鋼絲之斷裂，與病人年齡和術後時間長度有關聯。
方法: 我們檢索和分析本院11年的醫療紀錄（由2000年1月1日至2011年5月31日）。納入標準為：（1）橫行髕骨骨折之患者接受了張力帶及環扎鋼絲內固定治療，（2）並且在本院取出鋼絲植入物，（3）單側髕骨骨折，（4）非因感染而需取出植入物，（5）鋼絲在骨折癒合後才取出，（6）非下極或粉碎性髕骨骨折，並沒有接受部分髕骨切除及保護性鋼絲伸膝裝置重建術，(7）骨折內固定日期不明之患者。我們研究鋼絲去除的原因，植入鋼絲的斷裂或遷移，以及骨折內固定與鋼絲取出之時間差。
結果: 59例被納入並研究。 28例於植入物取出時鋼絲完整，31例之植入鋼絲於取出時已斷裂。就患者進行骨折內固定時之年齡而言，完整鋼絲組和斷絲組之間，沒有統計學上的顯著性差異。然而，就骨折內固定與取

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出鋼絲之時間差而言，兩組患者卻有統計學上的顯著性差異。這表明，鋼絲斷裂的風險隨著術後的時間長度而增加。如果以12個月為分界，骨折內固定到取出鋼絲之時間差與鋼絲斷裂之發生有統計學上的關聯。在斷絲組的31例中，有7例鋼絲遷移，其中2人需要額以外的膕窩傷口取出植入物。
結論：髕骨張力帶鋼絲斷裂的風險與術後時間長度有關聯 ，但與患者進行骨折內固定時之年齡沒有關係。鋼絲斷裂的風險在骨折內固定的12個月後顯著增加。鋼絲斷裂可導致另外的病況或併發症。慣常性取出植入物可能是必須的。我們可能需要作進一步的長期前瞻性研究。

Introduction

Tension-band wiring with metal wires is a commonly used technique to treat transverse patella fractures.[1] Wire breakage is not uncommonly seen several years after the operations. Migration of broken wires is an uncommon complication of wire fixation for fracture patella.[2–4] It may cause further complications including nerve irritation[3] and migration to major organs such as heart.[5–7] We hypothesize that the breakage of patellar tension-band wires is related to the patient's age and the duration after fracture fixation.

Methods

We reviewed our hospital's database from January 1, 2000, to May 31, 2011, in the past 11 years. Our inclusion criteria were: inclusion criteria were: (1) patients with transverse patella fracture treated with tension-band plus cerclage wiring technique, (2) with their metal wires removed in our hospital, (3) unilateral patella fracture, (4) wire removal not due to infection, (5) wire removal after complete fracture union, (6) no fracture distal pole or partial patellectomy with protective wire loop, and (7) known exact date of the initial fracture fixation surgery.

Under the inclusion criteria, 59 cases were included into the study. There was only one wire loop for each wire.

We reviewed the reasons of wire removal, the presence of broken or migrated wires upon implant removal, and the time lapse from fracture fixation to wire removal.

The data were tested for deviation from normal distribution using the Kolmogorov-Smirnov test. For data that passed the normality test, unpaired T-test was used for analysis. For data that failed the normality test, Mann-Whitney test was used for analysis.

Results

Of the 59 patients, 28 (47.5%) of them had intact wires when undergone implant removal. For this group of patients, implant impingement (19 patients) was the most common reason for wire removal. Five patients, who were all asymptomatic, had their wires removed due to their own preference. Two patients complained persistent knee pain or discomfort and requested removal of the implants. One patient had the wires removed together with another unrelated surgery. The reason for wire removal for the remaining one patient was not retrievable.

A total of 31 patients (52.5%) were found to have broken metal wires. It was either found on the radiographs before the operation, or during the implant removal surgeries.

Table 1
Association between sex and the presence of broken wires upon implant removal

	Men	Women	Total
Number of patients with intact wires	13	15	28
Number of patients with broken wires	10	21	31
Total	23	36	59

Fisher's exact test: two-tailed p value = 0.2965.

A total of 46.4% and 32.3% of the patients were male in the intact wire and broken wire groups, respectively. By the Fisher's exact test, the association between sex and the presence of broken wires upon implant removal was statistically insignificant ($p = 0.2965$). This is shown in Table 1.

The mean ages at the initial fracture fixation were 53.67 and 56.86 years of age, respectively for the intact wire group and the broken wire group. The difference was also statistically insignificant ($p = 0.3406$). This is shown in Table 2.

The mean lengths of time from the initial fracture fixation to implant removal were 19.86 months and 74.42 months, respectively, for the intact wire group and the broken wire group. The difference was statistically significant ($p = 0.0008$). These results are shown in Table 3.

Among the 31 patients with broken wires, seven of them (22.6%) had migration of wire fragments either into the joint cavities or to the posterior compartment of the knees. Comparing the age of patients at fracture fixation for patients with migration of wire fragments and those without migration, there was no statistically significant difference ($p = 0.1441$). However, comparing the length of time from the initial fracture fixation to implant removal for these two groups of patients, the group of patients with wire migration has a longer time lapse, and the difference was statistically significant ($p = 0.017$). These results are shown in Table 4.

Using a 2 × 2 contingency table, the association between the length of time from the initial fracture fixation to implant removal and the presence of broken wire was analysed with Fisher's exact test (Table 5). The cumulative number of patients with broken wires (Figure 1), the p value of the Fisher's exact test (Figure 2), and the relative risk of wire breakage (Figure 3) were plotted using different cut-off time. The association between the time lapse and the presence of broken wire became statistically significant when 12 months or longer length of time was used as the cut-off. The relative risk of wire breakage was 2.016 for a time lapse of 12 months.

Discussion

Although breakage of metal wires in operated patella fractures (Figure 4) was described as an uncommon complication in previous literatures, the exact incidence and prevalence have not been clearly stated.[2,3–5] Broken wires in fracture patella can migrate intra-articularly[2,4] to the popliteal fossa[6] and even to the heart.[5] Migrated broken wires at the posterior compartment of the knee can also cause nerve irrigation due to its proximity to the neurovascular bundle.[3]

Table 2
Age of patients at initial fracture fixation (y)

Group	Intact wire	Broken wire	p value; two-tailed (unpaired t-test)
Mean	53.67	56.86	0.3406
Standard deviation	12.93	12.59	
Standard error of the mean	2.44	2.26	
Number of patients	28	31	

Table 3
Length of time from the initial fracture fixation to implant removal (mo)

Group	Intact wire	Broken wire	*p* value; two-tailed (Mann-Whitney test)
Mean	19.86	74.42	0.0008
Standard deviation	15.52	77.65	
Standard error of the mean	2.93	13.95	
Number of patients	28	31	

Removal of wires is recommended after the fractures have healed, but the principles behind were not stated.[8,9] Another author, on the other hand, suggested that asymptomatic implants might be retained indefinitely.[10] We initially hypothesized that patients with younger age have a higher risk of wire breakage due to their higher activity level and more sports participation. Therefore, in our institution, we did not routinely remove the wires of asymptomatic patients unless they were young or active sport participants. In this study, there was no statistically significant difference between the age of the patient in the intact wire group and the broken wire group. However, for the length of time from fracture fixation to implant removal, the difference was statistically significant between the two groups of patients. It suggested that the risk of wire breakage increases with time after patellar tension-band wiring. Comparing to elderly patients, younger patients had higher cumulative risk of wire breakage probably due to their longer life span, rather than their activity level.

In this study, patients with their wires removed at more than or equal to 12 months from their initial surgery, were associated with a higher risk of wire breakage. The relative risk further increased if longer length of time was used as cut-off. This finding suggested that the tension-band and cerclage wires inside the quadriceps and patellar tendon are subjected to repetitive loading and strain to the metal wires even after the fracture has healed. Thus, given enough time, the wires may eventually break if not removed.

Among our patients with broken wires, 22.6% had their wire fragments migrated (Figure 4). Their mean time lapse from fracture fixation was significantly longer than those without migration. It may signify the broken wire will migrate with time. However, a longer longitudinal study may be carried out to confirm this theory. Two patients required another open wound at the popliteal fossa in order to remove the migrated wire. One of these two patients required an extra operation and anaesthesia because the first implant removal surgery failed to remove the migrated wire due to technical difficulty. Therefore a migrated wire could be associated with extra morbidity. Moreover, posterior approach to the knee at the popliteal fossa is associated with neurovascular injury.

As a matter of fact, if the patients are medically fit for operation, we recommended removal of all wires after the healing of fracture patella 1 year after the initial fracture fixation.

Table 4
Presence of wire migration among patients with broken wires upon implant removal

	No wire migration	Wire migration	*p* value; two-tailed
Mean age of patients at initial fracture fixation (y)	58.66	50.70	0.1441 (unpaired *t*-test)
Mean length of time from the initial fracture fixation to implant removal (mo)	58.58	128.71	0.0170 (Mann-Whitney test)
Number of patients	24	7	

Table 5
Fisher's exact test

Length of time from the initial fracture fixation to implant removal (mo)	Number of patients with intact wire	Number of patients with broken wire	Total number of patients
≤ 12	12	4	16
> 12	16	27	43
Total number of patients	28	31	59

p value (two-tailed) = 0.0176. Relative risk = 2.016 (95% confidence interval: 1.247–3.259).

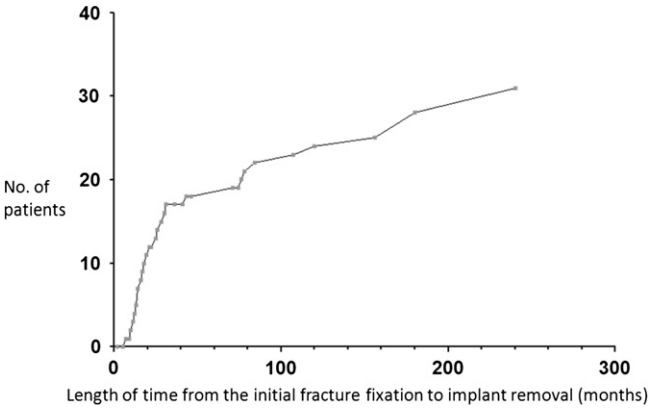

Figure 1. Cumulative number of patients with broken wire over time.

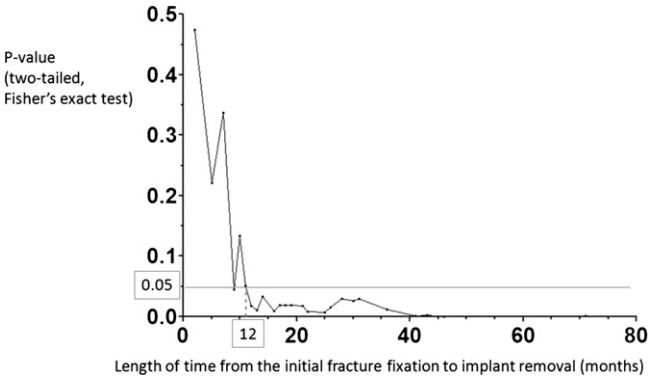

Figure 2. Association between time lapse from the initial fracture fixation and the presence of broken wire upon migration using different cut-off time.

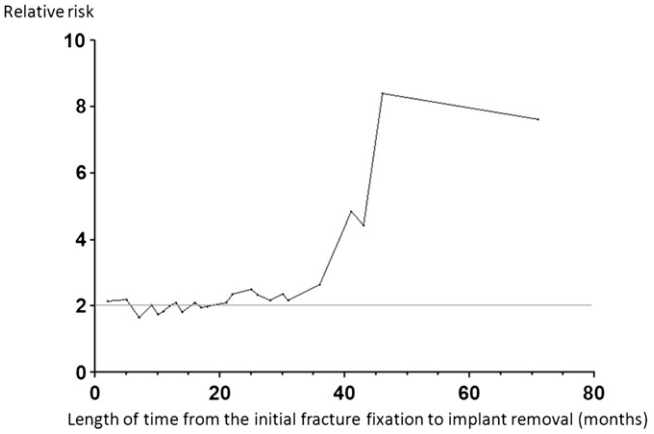

Figure 3. Relative risk of wire breakage.

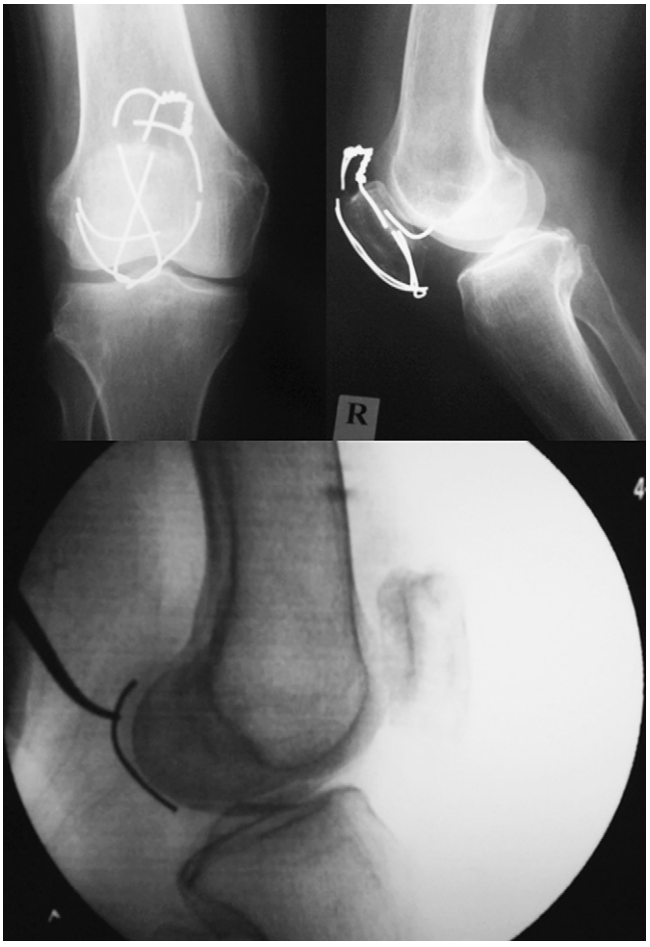

Figure 4. Upper radiographs: broken tension-band wires. Lower radiographs: intra-operative film showing intra-articular migration of wire to the popliteal fossa.

There were several limitations in this study. Firstly, the chosen population was those with wire removal surgery performed in one institution. The reasons of implant removal were different for the two comparing groups. For the intact wire group, there were different reasons of implant removal. On the other hand, for the broken wire group, most of the patients removed their wires because they were found broken upon radiographs. Therefore, there was presence of sampling bias.

Secondly, there was high follow-up default rate for asymptomatic patients with healed fracture patella in our locality. Since these asymptomatic or defaulted patients were not included in the analysis, the study result of our selected groups may not be extrapolated to fit the entire population of the operated patients.

Thirdly, although we could standardise the type of implants used for fracture fixation, the wiring technique and the number of knots, there were many other non-standardised factors such as the knee angle at wire tightening, the tension of wires, the patients' compliance and the post-operative rehabilitation regime. These variables may also contribute to the breakage of wires. Future studies with more in-depth analysis of these factors may be necessary.

Finally, this was a retrospective study with non-randomised samples. Future prospective longitudinal long-term studies are needed.

Conclusion

The finding of this study suggested that the risk of wire breakage was associated with increase time lapse from fracture patella fixations, but not the patients' age upon fracture fixation. The risk of wire breakage significantly increases after 12 months from the fracture fixation. Wire breakage could lead to further morbidities or complications. The risk of wires migration may also increase with time. Routine removal of wire loops may be indicated.

References

1. Weber MJ, Janecki CJ, McLeod P, et al. Efficacy of various forms of fixation of transverse fractures of the patella. *J Bone Joint Surg Am* 1980;**62**:215–20.
2. Chen Y, Wu C, Hsu R, et al. The Intra-articular migration of the broken wire: a rare complication of circumferential wiring in patellar fractures. *Chang Gung Med J* 1993;**17**:276–9.
3. Choi HR, Min KD, Choi SW, et al. Migration to the popliteal fossa of broken wires from a fixed patellar fracture. *Knee* 2008;**15**:491–3.
4. Hsu WH, Huang HC, Tsai YH, et al. Fluoroscopic-controlled, arthroscopic removal of intra-articular broken wire after patellar fracture. *Injury Extra* 2006;**37**:86–9.
5. Biddau F, Fioriti M, Benelli G. Migration of a broken cerclage wire from the patella into the heart. A case report. *J Bone Joint Surg Am* 2006;**88**:2057–9.
6. Daus GP, Drez Jr D, Newton Jr BB, et al. Migration of a Kirschner wire from the sternum to the right ventricle. A case report. *Am J Sports Med* 1993;**21**:321–2.
7. Wirth MA, Lakoski SG, Rockwood Jr CA. Migration of a broken cerclage wire from the shoulder girdle into the heart: a case report. *J Shoulder Elbow Surg* 2000;**9**:543–4.
8. Whittle AP. Fractures of the lower extremity. In: Canale ST, Beaty JH, editors. *Campell's operative orthopaedics*. 11th ed. Philadelphia: Mosby Elsevier; 2007. p. 3161–8.
9. Nerlich M, Bernhard W. Patella. In: Ruedi TP, Murphy WM, editors. *AO principle of fracture management*. 1st ed. New York: AO Publishing; 2000. p. 487–501.
10. Archdeacon MT, Saunders RW. Patella fracture and extensor mechanism injuries. In: Browner BD, Jupiter JB, Levine AM, editors. *Skeletal trauma*. 4th ed. Philadelphia: Saunders Elsevier; 2009. p. 2131–66.