

# Separate Vertical Wiring for Comminuted Inferior Pole Fractures of Patella: An Effective Technique

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## ABSTRACT

**Introduction:** Comminuted inferior pole fractures of patella can be up to one-fifth of all patella fractures according to various studies. Management of these fractures is challenging because of very small fragment size to be amenable to conventional fixation techniques. Partial patellectomy is no longer favored due to its high incidence of complications. Separate vertical wiring technique of Yang and Byun is one of the methods of internal fixation reported with successful clinical outcome.

**Materials and methods:** This is a prospective study of consecutive cases of comminuted inferior pole fractures of patella which were treated with separate vertical wiring technique from January 2017 to February 2020. We have operated 32 cases of which only 28 cases available for a minimum follow-up of 2 years were included in the study. Depending upon the number of comminuted fragments in the inferior pole, three or four vertical tunnels were made. Stainless steel wire of size 0.9 mm (20G) was used for the vertical wiring.

**Results:** We have analyzed the time taken for union by radiological follow-up at fortnightly intervals. The mean time taken for union in our study was 8.3 weeks. Clinical grading scale by Böstman et al. was used to assess the outcome at 2 years follow-up. The mean score was 28.4 (maximum of 30) in our study.

**Conclusion:** We conclude that separate vertical wiring is a reliable, reproducible, relatively simple, and cost-effective procedure in the treatment of comminuted inferior pole fractures of patella.

**Keywords:** Comminuted fracture, Inferior pole of patella, Separate vertical wiring.

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## INTRODUCTION

The incidence of comminuted inferior pole fractures of patella ranges from 5 to 22.4% of all patella fractures in different studies.<sup>1-3</sup> Lazaro et al. reported a high prevalence of patella inferior pole comminution (88%) visible on computerized tomography which was not visualized in plain radiography.<sup>4</sup> Comminuted inferior pole fracture of patella are difficult fracture to manage and to date, there is no standard method of treatment is available. Since the comminuted fragments are too small to be fixed by conventional techniques of tension band wiring (TBW), partial patellectomy was the treatment traditionally.<sup>5</sup> However, the partial patellectomy was associated with many complications and disadvantages like prolonged immobilization, delayed rehabilitation, and quadriceps weakness in addition to patella baja.<sup>5</sup>

As the partial patellectomy was associated with higher incidence of complications, newer techniques of osteosynthesis were proposed by many authors like certain modifications in TBW, newer plates, and use of suture anchors.<sup>2,6-10</sup> Yang and Byun proposed a technique of separate vertical wiring for these difficult fractures with an excellent outcome in a series of 25 cases. They have also done a biomechanical study to assess the better ultimate load to failure with separate vertical wiring in comparison to pull-out sutures.<sup>1</sup>

We have followed the technique of separate vertical wiring in our institution in a series of cases and analyzed the functional and radiological outcome.

## MATERIALS AND METHODS

This is a prospective study of consecutive cases of comminuted inferior pole fractures of patella which were treated with separate

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vertical wiring technique from January 2017 to February 2020. The study was approved by our Institutional Ethics Committee. We have operated 32 cases of which only 28 cases available for a minimum follow-up of 2 years were included in the study (Table 1). Two patients expired due to coronavirus disease (COVID) pneumonia during the first wave of COVID pandemic and one patient during the second wave of COVID pandemic. Whereabouts of one more patient were not known.

Comminuted inferior pole fractures of patella, where the comminuted fragments are too small for conventional TBW, in all age-groups were included in the study presented within 3 weeks of injury. Twenty-six cases were closed injury and two cases were grade II open injury. We have excluded when the fracture extended into the body of patella where additional procedures

Table 1: Master chart

Sl no.	Age	Sex	Side	Number of vertical wires	Time to union	Follow-up in months	Range of motion (flexion lag vs opposite side)	Complication	Boston score	Outcome
1	42	M	R	3	8	24	0-1400	Nil	30	E
2	36	M	L	3	8	24	0-1350	Nil	29	E
3	47	M	R	4	10	36	0-1400	Nil	29	E
4	44	F	R	3	8	48	0-1400	Nil	28	E
5	19	M	R	3	8	36	0-1350	Nil	30	E
6	21	M	L	3	8	42	0-1400	Nil	29	E
7	64	F	L	3	12	24	0-125 (10)	Supl infec	23	G
8	53	M	L	4	10	24	0-1350	Nil	28	E
9	43	M	R	3	8	30	0-1300	Nil	30	E
10	22	M	L	4	8	30	0-1350	Nil	28	E
11	27	M	R	3	8	24	0-1300	Nil	30	E
12	62	F	R	3	8	24	0-130 (5)	Nil	27	G
13	56	F	R	3	8	30	0-1350	Nil	29	E
14	60	M	R	3	10	30	0-125 (10)	Nil	25	G
15	34	M	L	3	8	24	0-1300	Nil	28	E
16	49	F	R	4	8	42	0-1350	Nil	29	E
17	51	M	R	3	8	30	0-1400	Nil	29	E
18	25	M	L	4	8	24	0-135 (5)	Nil	26	G
19	40	M	L	3	10	24	0-1350	Nil	30	E
20	35	F	R	3	12	36	0-130 (5)	Nil	25	G
21	53	M	L	3	8	42	0-1350	Nil	28	E
22	31	F	R	4	8	24	0-1400	Nil	30	E
23	39	M	L	4	8	24	0-1300	Nil	29	E
24	42	M	L	3	8	24	0-1400	Nil	28	E
25	59	M	R	3	8	24	0-1350	Nil	27	G
26	37	F	R	3	8	24	0-125 (5)	Nil	28	E
27	52	M	R	3	8	24	0-1400	Nil	29	E
28	43	M	L	3	8	24	0-1350	Nil	30	E

were required. Comminuted inferior pole fractures of patella with concomitant injury to other bones or ligaments of the same limb were also excluded.

Age-group of the patients ranges from 19 to 64 years. Of the 28 cases, 19 were male, and right patella was affected in 16 cases. The mode of injury was road traffic accident in 15 cases, fall while playing in 7 cases, and domestic fall in 6 cases.

### Surgical Technique

All the patients were operated on under spinal anesthesia. Open fractures were dealt with as per standard protocol. Tourniquet was not used in any of the cases. We used vertical incision in all cases except the two cases of grade II open fractures where the original wound was extended proximally and distally. Fracture site was irrigated to clear off the clots and loose fragments.

Vertical tunnels were made in the proximal fragment starting from posteroinferior aspect to anterosuperior aspect of patella, using a 1 mm K wire (Fig. 1). The number of tunnels was decided based on the number of major comminuted fragments. In majority of cases, we made three tunnels and, in few cases, fourth tunnel was required to engage all the fragments. Stainless steel wire of size 0.9 mm (20G) was passed through the bony tunnels in the proximal fragment in all the tunnels. Then the wire was passed

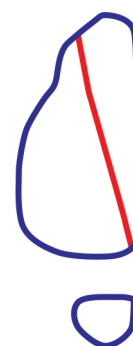
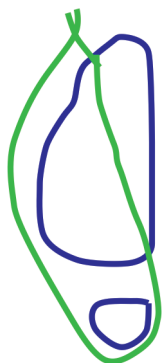
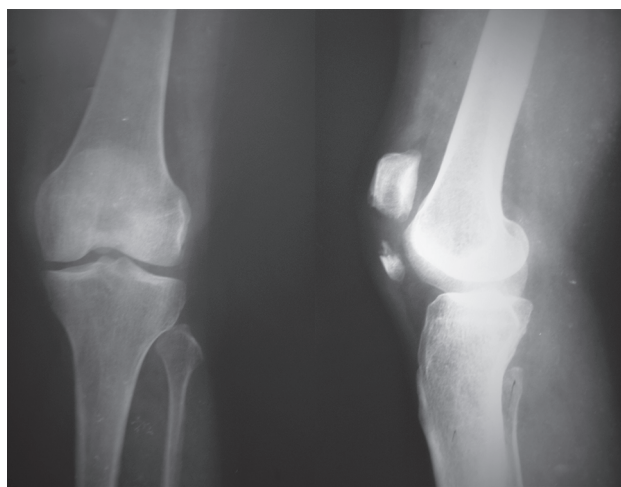


Fig. 1: Diagram showing the vertical tunnel (red line) from posteroinferior to anterosuperior aspect of proximal fragment of patella

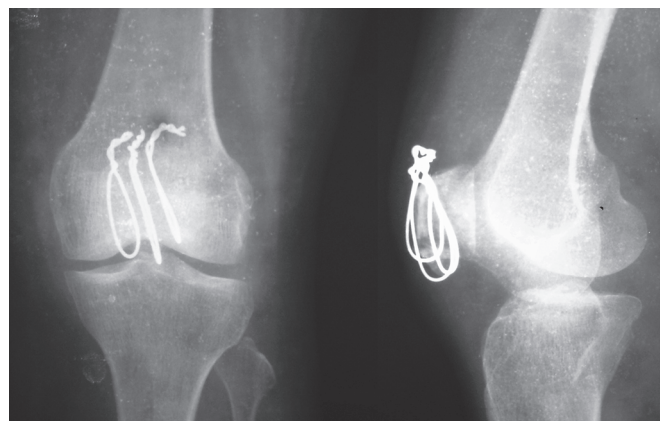
posterior to the inferior pole fragments, encircling the inferior pole fragments, brought anteriorly and tightened in the superior aspect of the patella (Fig. 2). All the three or four vertical wires were tightened in the similar way one by one (Figs 3 and 4). Rents in the extensor retinaculum were repaired using number 1 polyglactin 910 sutures. At this stage, perioperatively, knee joint was flexed to 90° to ensure that no separation of fracture fragments. The wound was closed in layers.



**Fig. 2:** Diagram showing the wire loop (green line) being passed posterior to the inferior pole fragments, encircling the inferior pole fragments, brought anteriorly and tightened in the superior aspect of the patella



**Fig. 3:** Preoperative X-ray anteroposterior and lateral view of left knee showing comminuted fracture of inferior pole of patella

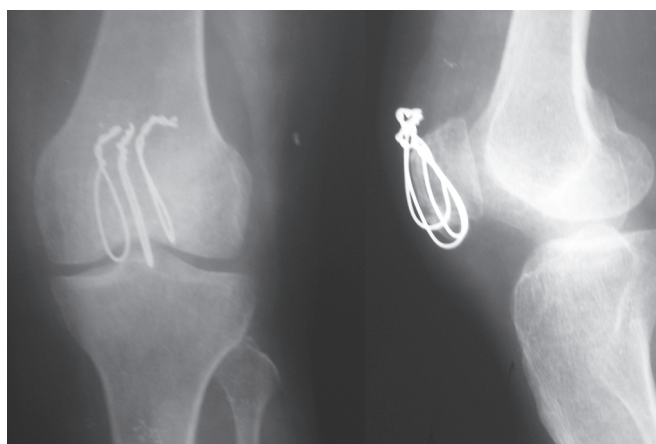


**Fig. 4:** Postoperative X-ray anteroposterior and lateral view of left knee showing comminuted fracture of inferior pole of patella well reduced with separate vertical wiring *in situ*

Postoperatively, knee was immobilized in a detachable knee brace. Intermittent knee mobilization was started from the 2nd postoperative day, gradually increasing up to 90° over 2 weeks and full range of movement in 6 weeks. Toe touch weight bearing was



**Fig. 5:** Clinical picture at 2-year follow-up showing active straight leg raising without extensor lag



**Fig. 6:** Postoperative X-ray anteroposterior and lateral view of left knee at 2-month follow-up showing fracture union

allowed with brace from 2nd postoperative day and full weight bearing was allowed after 6 weeks.

Patients were followed up initially at weekly interval for 6 weeks, then at fortnightly interval till radiological union, and then once in 6 months up to 2 years. Knee function was evaluated using clinical grading scale of Böstman et al. at 2 years follow-up (Fig. 5).

Knee radiographs were taken in the immediate postoperative period, at 1-month follow-up, every fortnight till fracture union, and then at 6-month intervals. Radiological union was defined as obliteration of all fracture lines (Fig. 6).

## RESULTS

The mean age was 42 years. The mean operating time was 72 minutes (43–98 minutes). Three wires were used in 21 cases and four wires were used in seven cases. All the fractures went in for union without any secondary intervention. The mean time to radiological union was 8.5 weeks (8–12 weeks).

One patient had superficial infection which healed on regular dressing and antibiotics. We have not encountered any case of implant prominence or wire breakage at a minimum follow-up of 2 years. About 22% of patients had limitation of terminal 5–10° of knee flexion compared to contralateral side. None of the patients had extensor lag.

To assess the clinical outcome, we used the clinical grading by Böstman et al.<sup>11</sup> A 2-year follow-up showed excellent outcomes in 79% of cases and good in 21% of our cases.

## DISCUSSION

Comminuted inferior pole fractures of patella were traditionally treated by partial patellectomy, which is associated with many disadvantages as tendon-to-bone healing took longer time, need for patella tibial wiring to protect the repair until it heals and patella baja.<sup>5</sup> Conventional methods of osteosynthesis like TBW and cerclage wiring are not effective in stabilizing the comminuted small fragments in inferior pole of patella.<sup>1</sup>

Hence, many modifications were proposed by various authors. Modifications in TBW were proposed by Gao et al. and Zhang et al.<sup>12,13</sup> Various plating techniques were also proposed. Basket plate was one of the earliest plates used for comminuted inferior pole fractures of patella. It offered better solutions to the problems of partial patellectomy and was also found to be biomechanically superior to TBW.<sup>14,15</sup> However, it is not widely available. According to Krkovic et al., basket plate can cause significant shortening and rupture of the patellar ligament.<sup>16</sup>

Since then, different types of plates like custom made anchor like plate by Li et al., mini plate with TBW by Zhu et al., hook plate with cable cerclage by Gu et al., rim plating by He et al., anchor loop plate by Du et al. were used to treat comminuted inferior pole fractures of patella.<sup>2,6–8,16,17</sup> All the newer plating techniques claimed to have given good outcome by those who designed the technique. However, further studies by other authors to support the claim are not available.

Recently Xie et al. and Yu et al. used suture anchors with successful clinical results.<sup>9,10</sup> Newer concept of patellar concentrator was proposed by Chen et al. with favorable clinical outcome.<sup>18</sup> However, the major limiting factor in these techniques is the cost of the materials in a low socioeconomic condition.

Separate vertical wiring technique was published in 2003 by Yang and Byun with successful clinical and biomechanical results.<sup>1</sup> Subsequently Song et al. proposed a modification in this separate vertical wiring technique with a supplementary cerclage wiring to improve the ultimate load to failure from  $216.4 \pm 72.4$  N to  $324.9 \pm 50.6$  N. Interestingly, there were no incidences of wire breakage in the case series of Yang, whereas there was a 20% incidence of wire breakage in the case series of Song.<sup>1,19</sup>

Yang and Song have used 0.75 mm suture wires for the separate vertical wiring.<sup>1,19</sup> Instead, we have used 0.9 mm stainless steel wires. In addition, we have meticulously repaired the rents in the extensor retinaculum. Hoping that increasing the thickness of the wire will address the issues of ultimate load to failure and wire breakage. However, we have not done any biomechanical study to support this hypothesis. Incidentally, we have not encountered any wire breakage or required any secondary procedures for wire-related complications in our study.

We have achieved union in all 28 cases with a mean of 8.3 weeks of time to heal which is comparable to other reported studies. As per the clinical grading scale of Böstman et al., the mean score in our study is 28.4 (maximum of 30) which is also comparable to the published results of separate vertical wiring technique by other authors and also to those of newer plating and suture anchors.

However, certain limitations in our study including smaller study population, lack of control group, and absence of biomechanical study to test the ultimate load to failure on increasing the wire size

from 0.75 to 0.9 mm are to be kept in mind to necessitate further studies in this context.

## CONCLUSION

We conclude that separate vertical wiring is a reliable, reproducible, relatively simple, and cost-effective procedure in the treatment of comminuted inferior pole fractures of patella.

## Clinical Significance

Our study favors the separate vertical wiring procedure in the treatment of comminuted inferior pole fractures of patella for the following reasons.

- No special instrument or implants or required.
- Learning curve is not difficult.
- Results are comparable to other available surgical techniques.

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