

Fig. E-1

Figs. E-1A, E-1B, and E-1C Radiographs of patient 21, a ten-year-old boy with type-IV osteogenesis imperfecta. **Fig. E-1A** A cortical gap at the right tibial diaphysis that had persisted from four years of age even with intramedullary rod fixation; an angular deformity gradually developed. **Fig. E-1B** An anterior wedge of bone was excised from the cortical gap site, the bent intramedullary rod was replaced with a longer rod, and a locking plate was applied with unicortical screws. **Fig. E-1C** The cortical gap healed completely in a year.

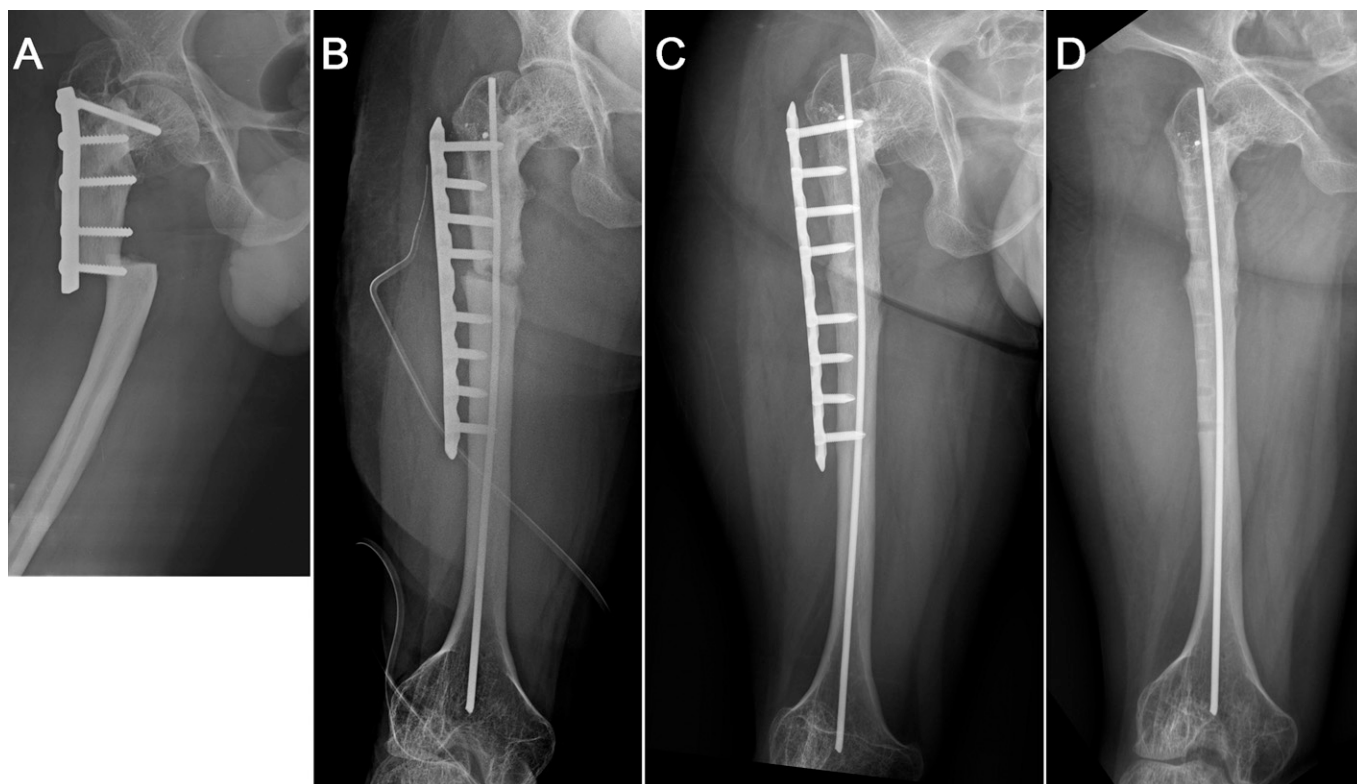


Fig. E-2

Figs. E-2A through E-2D Radiographs of patient 20, a thirty-one-year-old man with type-IV osteogenesis imperfecta. His body weight was 52 kg, his height was 144 cm, and his body mass index was 25.1 kg/m². **Fig. E-2A** The patient sustained a left femoral shaft fracture at the tip of the dynamic compression plate that had been implanted six years ago at another hospital. **Fig. E-2B** Because the medullary canal was so narrow, only a 3.5-mm flexible intramedullary rod could be inserted, and unicortical locking plate fixation was added. **Fig. E-2C** In sixteen months, osseous union was achieved. **Fig. E-2D** The plate and screws were removed, leaving the intramedullary rod behind.

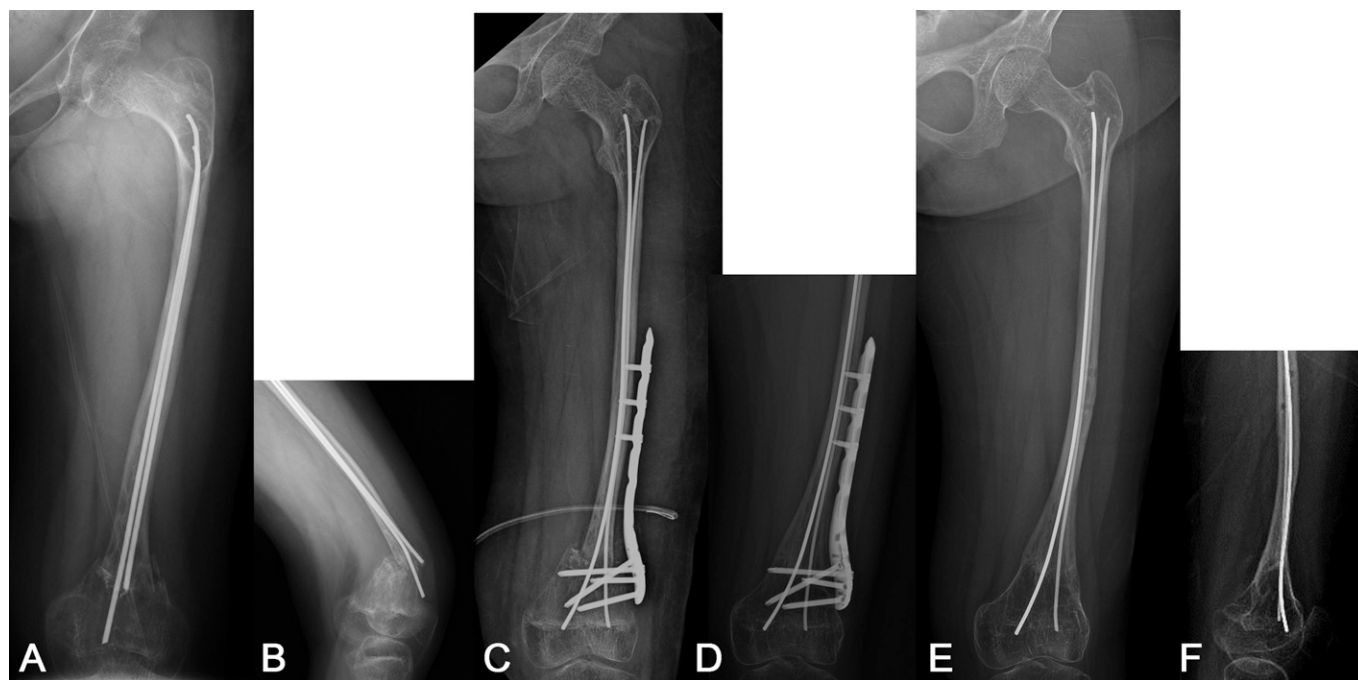


Fig. E-3

Figs. E-3A through E-3F Radiographs of patient 16, a fourteen-year-old girl with type-IV osteogenesis imperfecta. **Figs. E-3A and E-3B** The patient sustained a fracture at the distal femoral metaphysis. **Fig. E-3C** Preexisting flexible rods were replaced with longer rods, and a locking anatomical plate was applied with unicortical screws. **Fig. E-3D** The fracture healed uneventfully. **Figs. E-3E and E-3F** The plate and screws were removed at fifteen months postoperatively and the flexible rods were left in place.

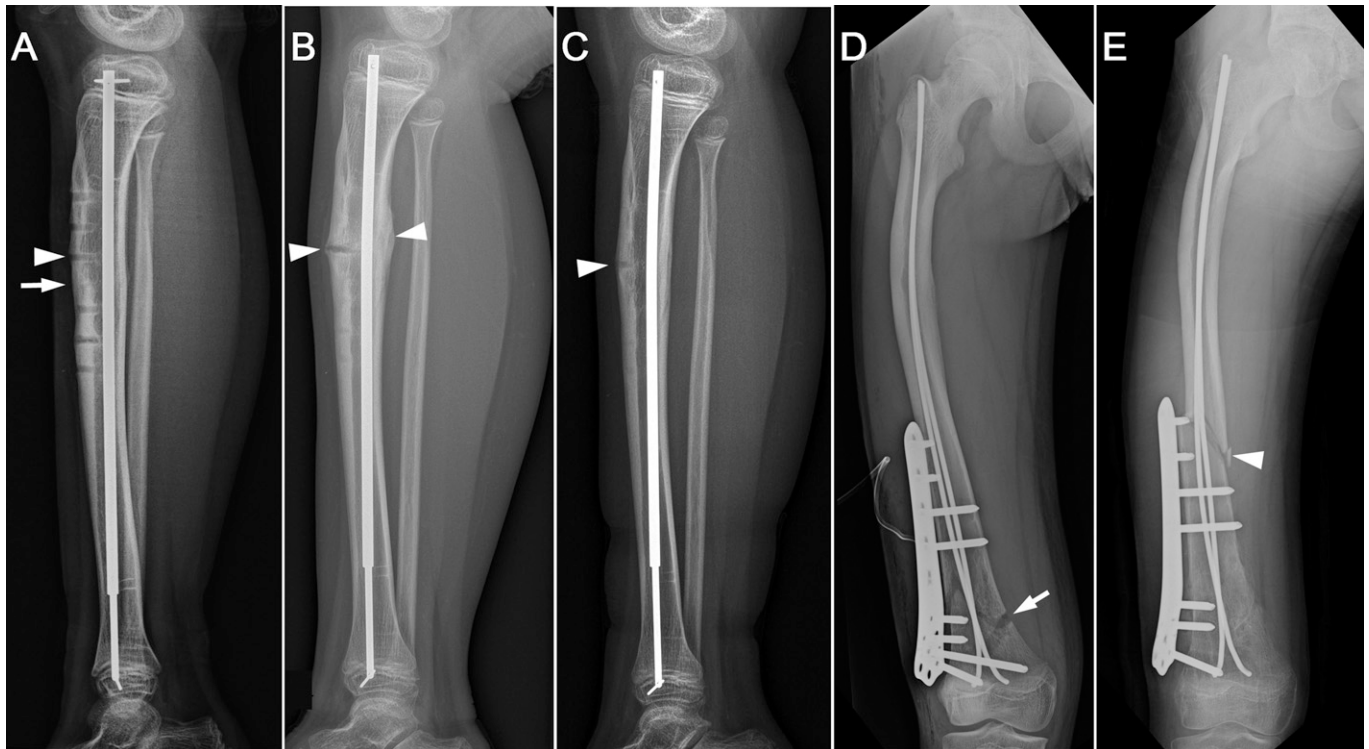


Fig. E-4

Figs. E-4A through E-4E Radiographs showing screw hole-related complications. **Fig. E-4A** Patient 24, a boy with type-IV osteogenesis imperfecta, had the plate and screws removed at ten years of age when the osteotomy site at the persistent cortical gap achieved complete healing (arrow). An arrowhead indicates the screw hole where the fracture develops in Fig. E-4B. **Fig. E-4B** However, one of the screw holes propagated to the posterior cortex where it caused a periosteal reaction (arrowheads) ten months after the plate removal. **Fig. E-4C** Three months later, the posterior cortex remodeled and the anterior screw hole (arrowhead) decreased in size. **Fig. E-4D** In patient 22, a thirteen-year-old boy with type-I osteogenesis imperfecta, a distal femoral metaphyseal fracture (arrow) was fixed with flexible intramedullary rods and a locking plate. **Fig. E-4E** Three months postoperatively, the fracture site had healed, but another fracture (arrowhead) occurred through the proximal screw hole after the patient sustained a fall.

TABLE E-1 Pertinent Data on the Thirty-seven Involved Bone Segments in Twenty-four Patients

Patient No.	Sex	Sillence Type	Involved Bone Segment	Age at Index Operation (yr)	Type of Index Operation*	Reason for Plating	Bisphosphonate Treatment†	Plate-Related Complication (Mechanism of Injury)
1	F	III	Left femur	20	ORIF	To ensure healing	None	None
1	F	III	Right femur	23	Corrective osteotomy	To ensure healing	None	None
2	F	III	Left femur	10	Plating only	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	None
2	F	III	Right humerus	10	ORIF	Metaphyseal fixation	PAM or ZOL during locking plate fixation	None
3	M	IV	Left femur	16	ORIF	To ensure healing	ALEN, discontinued before plate fixation	None
4	M	III	Left femur	30	ORIF	Metaphyseal fixation	None	None
5	F	III	Left femur	11	Corrective osteotomy	Rotational osteotomy	PAM or ZOL during locking plate fixation	None
5	F	III	Left tibia	11	Corrective osteotomy	Metaphyseal fixation	PAM or ZOL during locking plate fixation	None
6	F	III	Left femur	11	Plating only	Nonunion or persistent cortical gap	PAM during locking plate fixation	None
6	F	III	Right humerus	11	Corrective osteotomy	Nonunion or persistent cortical gap	PAM during locking plate fixation	None
6	F	III	Right tibia	11	Corrective osteotomy	Nonunion or persistent cortical gap	PAM during locking plate fixation	None
7	F	III	Left femur	37	Osteosynthesis	Nonunion or persistent cortical gap	None	None
8	M	IV	Left femur	12	ORIF	To ensure healing	PAM or ZOL during locking plate fixation	Linear fracture at screw hole (bearing weight)
8	M	IV	Right tibia	14	Corrective osteotomy	To ensure healing	PAM or ZOL during locking plate fixation	None
9	M	III	Left femur	15	Corrective osteotomy	To ensure healing	ALEN, discontinued before plate fixation	None
9	M	III	Right femur	15	Corrective osteotomy	To ensure healing	ALEN, discontinued before plate fixation	None

continued

TABLE E-1 (continued)

Patient No.	Sex	Sillence Type	Involved Bone Segment	Age at Index Operation (yr)	Type of Index Operation*	Reason for Plating	Bisphosphonate Treatment†	Plate-Related Complication (Mechanism of Injury)
10	F	III	Left tibia	12	Plating only	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	Linear fracture at screw hole (fall)
11	F	IV	Right femur	40	Corrective osteotomy and osteosynthesis	Nonunion or persistent cortical gap	None	None
12	M	V ¹²	Right femur	14	ORIF	To ensure healing	PAM during locking plate fixation	None
13	F	IV	Left femur	12	Corrective osteotomy	Rotational osteotomy	PAM during locking plate fixation	None
14	M	IV	Left femur	13	ORIF	To ensure healing	PAM or ZOL during locking plate fixation	None
14	M	IV	Right femur	14	Corrective osteotomy and osteosynthesis	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	None
14	M	IV	Left tibia	14	Corrective osteotomy and osteosynthesis	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	None
14	M	IV	Right tibia	14	ORIF	To ensure healing	PAM or ZOL during locking plate fixation	None
15	F	III	Left tibia	17	Corrective osteotomy	Nonunion or persistent cortical gap	ALEN, discontinued before plate fixation	Angulated fracture at screw hole (spontaneous gradual phenomenon)
15	F	III	Left femur	18	Plating only	Nonunion or persistent cortical gap	ALEN, discontinued before plate fixation	None
16	F	IV	Left femur	14	ORIF	Metaphyseal fixation	PAM during locking plate fixation	None
17	M	I	Right femur	14	Corrective osteotomy	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	Angulated fracture at screw hole (blunt trauma)
18	M	V ¹²	Left femur	12	ORIF and corrective osteotomy	To ensure healing	PAM or ZOL during locking plate fixation	None
19	M	IV	Right femur	15	Corrective osteotomy and osteosynthesis	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	None

continued

TABLE E-1 (continued)

Patient No.	Sex	Sillence Type	Involved Bone Segment	Age at Index Operation (yr)	Type of Index Operation*	Reason for Plating	Bisphosphonate Treatment†	Plate-Related Complication (Mechanism of Injury)
19	M	IV	Left femur	16	Corrective osteotomy	Nonunion or persistent cortical gap	PAM or ZOL, discontinued before plate fixation	None
20	M	IV	Right femur	31	ORIF	To ensure healing	None	None
21	M	I	Right tibia	10	ORIF	Nonunion or persistent cortical gap	ALEN or PAM during locking plate fixation	None
21	M	I	Left femur	11	ORIF	Nonunion or persistent cortical gap	ALEN or PAM during locking plate fixation	None
22	M	I	Right femur	13	ORIF	Metaphyseal fixation	PAM during locking plate fixation	Minimally displaced fracture at screw hole (fall)
23	M	III	Right femur	6	ORIF	Nonunion or persistent cortical gap	PAM or ZOL during locking plate fixation	Linear, asymptomatic fracture at screw hole (spontaneous gradual phenomenon)
24	M	IV	Right tibia	9	Corrective osteotomy	Nonunion or persistent cortical gap	PAM, discontinued before plate fixation	Linear, asymptomatic fracture at screw hole (spontaneous gradual phenomenon)

*ORIF = open reduction and internal fixation. †PAM = intravenous pamidronate, ZOL = intravenous zoledronate, and ALEN = oral alendronate.

TABLE E-2 Clinical Course of the Cases Having a Nonunion or Persistent Gap Treated by Locking Plate Fixation

Patient No.	Involved Bone Segment	Age at Previous Intervention (yr)	Status at Previous Intervention*	Type of Previous Intervention†	Gap* Duration (yr)	Age at Index Operation (yr)
2	Left femur	5	Angulation at gap	Corrective osteotomy	8.9	10
6	Right tibia	6	Angulation at gap	Corrective osteotomy	2.2	11
6	Left femur	7	Angulation	Corrective osteotomy	4.1	11
6	Right humerus	9	Fracture	CRIF	2.2	11
7	Left femur	30	Pseudarthrosis	Osteosynthesis	7.0	37
10	Left tibia	9	Angulation at gap	Corrective osteotomy	3.3	12
11	Right femur	37	Fracture	CRIF	3.2	40
14	Left tibia	5	Angulation at gap	Sofield operation	1.9	14
14	Right femur	6	Femoral retroversion	Rotational osteotomy	7.0	14
15	Left femur	7	Fracture	ORIF, additional osteotomy	0.2	18
15	Left tibia	11	Angulation at gap	Corrective osteotomy	0.2	17
17	Right femur	7	Angulation	Sofield operation	6.4	14
19	Right femur	5	Fracture	ORIF, additional osteotomy	7.6	15
19	Left femur	5	Angulation at gap	Sofield operation	11.0	16
21	Left femur	7	Fracture at gap	ORIF, additional osteotomy	6.9	11
21	Right tibia	7	Fracture at gap	ORIF	5.7	10
23	Right femur	5	Fracture	ORIF, additional osteotomy	1.3	6
24	Right tibia	3	Fracture	Cast immobilization	5.5	9

*"Gap" represents nonunion or persistent cortical gap. †CRIF = closed reduction and internal fixation, and ORIF = open reduction and internal fixation. ‡Auto = autogenous bone graft, and DBM = demineralized bone matrix. §The time to heal was the time after plating until the fracture or osteotomy line turned invisible on radiographs in both anteroposterior and lateral projections.

TABLE E-2 (continued)

Status Before Index Operation	Medullary Canal Reaming	Bone-Grafting†	Postoperative Immobilization	Time to Heal§ (mo)	Plate Duration (mo)	Follow-up Time After Plating (yr)
Pain only	No	No	No	28	29	3.7
Progressive angulation	To insert larger rod	No	Splint for 8 wks	11	19	2.8
Pain only	No	No	No	9	12	2.2
Progressive angulation	No	No	Splint for 4 wks	2	19	2.8
Pain, broken rod	Obliterated marrow space	Auto and DBM	No information	36	36	5.8
Pain only	No	No	Continued brace	7	7	1.0
Pain, broken rod	To insert larger rod	Auto and DBM	Splint for 4 wks	17	17	2.8
Progressive angulation	Obliterated marrow space	No	Cast for 8 wks	2	26	3.2
Progressive angulation	No	No	Splint for 4 wks	17	31	3.6
Pain only	No	No	No	19	31	4.2
Pain, broken rod	To destroy wrong tract	No	No information	14	45	5.4
Progressive angulation, pain, rod cutting-through	To destroy wrong tract	No	Splint for 4 wks	14	13	1.2
Progressive angulation, rod backing-out	To insert larger rod	No	Splint for 4 wks	3	7	3.4
Progressive angulation, rod cutting-through, distal migration of female rod	To insert larger rod	Auto	Splint for 4 wks	13	13	1.9
Fracture at gap*	To insert larger rod	Auto	Splint for 8 wks	11	15	1.7
Fracture at gap*	Obliterated marrow space	Auto and DBM	Cast for 8 wks	25	30	2.9
Fracture at gap*	No	No	Splint for 4 wks	14	17	4.3
Progressive angulation	Obliterated marrow space	No	Cast for 4 wks	15	15	2.5