Intra-articular fractures may result in stiffness, deformity, pain, and posttraumatic arthritis. In order to avoid deformity and stiffness it is necessary to secure an anatomical reduction of the articular surface, restore joint stability and normal axial alignment, and begin early motion. Sir John Charnley stated that “perfect anatomical restoration and perfect freedom of joint movement can be obtained simultaneously only by internal fixation” (Charnley 1961). At the time that Charnley wrote The Closed Treatment of Common Fractures, sufficiently stable and sufficiently strong internal fixation that would allow early motion was not available. Indeed, the results of internal fixation were so discouraging because of stiffness, deformity, delayed union, and nonunion that Charnley argued in favor of nonoperative treatment. His sentiments were soon echoed by Stewart et al. (1966) and Neer et al. (1967), who published the results of treatment of a major intra-articular fracture, the supracondylar fracture of the femur in the adult. Even with limited criteria of excellence which today would be thought unacceptable, such as the acceptance of 70° knee flexion as satisfactory (Neer et al. 1967), both groups found the results of surgery to yield just over 50% acceptable results. Stewart et al. went on to state that it was the added trauma of surgery and the presence of metal in periarticular locations which directly contributed to stiffness. A review of the publications of these authors and others makes it evident that the techniques of internal fixation then in existence and the implants available were totally inadequate. Sufficient stability could never be achieved to permit early pain-free motion. If motion was permitted, not only did pain inhibit motion and result in stiffness, but displacement and loss of reduction were also very common. To prevent displacement, internal fixation was combined with plaster fixation, and this invariably resulted in permanent stiffness.

The publication of the Swiss AO/ASIF group in 1970 (Wenzl et al. 1970), our own review (Schatzker et al. 1974), and other reviews (Mize et al. 1982; Olerud 1972; Schatzker and Lampert 1979) of results of treatment of major intra-articular injuries utilizing the AO methods and implants indicated strongly that with the new principles, methods, and implants, stable fixation and early motion after internal fixation was an attainable surgical goal, and that fractures – particularly intra-articular fractures – so treated did amazingly well.

The AO/ASIF methods of open reduction and internal fixation made strong, stable, and lasting fixation possible. Despite early, unprotected mobilization, accurate anatomical reduction of the joint and of the metaphyseal fractures could be maintained. Indeed, the patients were so completely free of pain that it was difficult to persuade them not to bear full weight and resume full function before union was complete.

The large number of patients who were treated nonoperatively (Schatzker et al. 1974, 1979) permitted us to make certain observations which we consider invaluable lessons in articular fracture treatment. Patients whose intra-articular fractures were immobilized in plaster for 1 month or longer ended with permanent marked stiffness of these joints. Patients with similar fractures which were treated by open reduction and internal fixation, but whose joints were subsequently immobilized in plaster, ended with far greater stiffness. Patients whose intra-articular fractures were treated by traction and early motion ended with varying degrees of joint incongruity, but invariably with a much better range of motion. This allowed us to formulate a principle of intra-articular fracture treatment: Displaced intra-articular fractures that are not treated by open reduction and stable internal fixation should be treated by traction and early motion.

Fractures that were treated by manipulation and traction often showed persistent displacement of some fragments. At surgery these fragments were always found to be firmly impacted into the metaphyseal cancellous bone and could be dislodged only by direct surgical manipulation. This permitted us to formulate the second principle of treatment: Intra-
Articular fragments which do not reduce as a result of closed manipulation and traction are impacted and will not reduce as a result of further manipulation or traction.

A number of cases of patients with intra-articular fractures which were initially treated closed but eventually operated on led to one further important observation: Major intra-articular depressions do not fill with fibrocartilage to restore joint congruity and instability. If a joint is unstable because of major joint depression, the instability will become permanent unless the fragment is reduced surgically and held in position until union occurs.

Pauwels (1961) postulated that in a normal joint there is a state of equilibrium between articular cartilage regeneration and articular cartilage destruction. Furthermore, he felt that articular cartilage wear occurred constantly, as a result of stress. As stress is the result of force acting on a specific surface area, that is, \( S = F/A \), it becomes clear that stress can be increased and the equilibrium tipped in favor of joint destruction either by decreasing the surface area of contact (A) or by increasing the force (F), or by both. F is increased above its physiologic level by axial overload, the result of a metaphyseal or diaphyseal deformity.

A consideration of the above led us to an inescapable conclusion: Anatomical reduction of the joint is essential to restore joint congruity and increase the surface area of contact to the maximum possible, and metaphyseal and diaphyseal deformity must be corrected to prevent axial overload (Fig. 2.1). Both the joint congruity and axial alignment are important in restoring joint stability.

These are similar to the principles of intra-articular fracture care enunciated by the AO (Müller et al. 1979), and we fully agree with them. The therapeutic validity of these principles is confirmed by the favorable results of modern operative treatment of intra-articular fractures.

What about articular cartilage damage sustained at the time of injury and the possibility of articular cartilage regeneration? In an elegant experiment, Mitchell and Shepard (1980) studied the effects of the accuracy of reduction and stable fixation. With the aid of histological methods and electron microscopy, they were able to show that anatomical reduction and stable fixation of intra-articular fragments by means of compression resulted in articular cartilage regeneration.

Salter et al. (1980, 1986) studied experimentally and clinically the effects of continuous passive motion on articular cartilage healing and regeneration. They demonstrated very convincingly that continuous passive motion stimulated both processes.

More recent investigations into step-off defects (Llinas 1993, 1994) have delineated the limits of positive step-off deformities, which should not exceed the thickness of the articular cartilage. These studies have also confirmed the limited ability of articular cartilage to remodel. They have further demonstrated the danger of a positive step-off deformity to the opposing articular surface in causing rapid degenerative change.

Magnetic resonance imaging (MRI) investigation of closed joint injuries has revealed “bruising” of the subchondral bone and has allowed a correlation between certain MRI patterns of bruising and subsequent osteochondral fragmentation and the formation of articular defects (Vell et al. 1991). Similar damage to articular cartilage and subjacent bone must also occur in association with fractures (Dickson et al. 2002). This points to the shortcomings of visual evaluation of articular cartilage injury and indicates why caution should be exercised in the prognosis of articular injuries, since some aspects of the injury may escape detection and are not influenced by treatment.

These experimental and clinical studies permit us to enunciate the principles of intra-articular fracture treatment as follows:

1. Immobilization of intra-articular fractures results in joint stiffness.
2. Immobilization of articular fractures treated by open reduction and internal fixation results in much greater stiffness.