A critical question in evaluation of knee injuries concerns the integrity of the capsuloligamentous structures. It is particularly important to exclude an injury of the cruciate ligaments, because an undetected rupture can lead to significantly intraarticular damage that is exceedingly difficult to treat [234, 285, 441, 466, 470]. It must be considered that ligament stability is not an end in itself but a prerequisite to achieving integral joint function with adequate closure and stability of the articular surfaces during movement.

In evaluating the ligaments of the knee, it is important to know the functional anatomy of the joint, i.e., the positions in which the joint is stabilized by the structures that are to be tested. The final diagnosis of a capsuloligamentous lesion is based not on a single laxity test but on a combination of varus-valgus testing, active and passive drawer tests, and pivot shift tests. The finding of medial opening with concomitant anterior displacement is neither an acceptable chart entry nor a satisfactory basis for initiating treatment [485].

Thus, labeling a case as a “sprained knee” is simply describing a mechanism of injury and is not a meaningful diagnosis.

Prolonged “prophylactic” immobilization of the knee in plaster is not an appropriate strategy [235], and a definitive diagnosis should be established within one week at the latest. Otherwise injuries become obscured and their prompt, adequate treatment is prevented. The motto “when in doubt, cast” should be condemned.

It is sobering to realize that 60% of cruciate ligament ruptures go undetected during the initial clinical examination, despite the fact that 93% of patients seek medical attention within a week after their injury [51]. As the modern diagnostic tests (Lachman test, active quadriiceps tests, pivot shift tests) become more widely utilized, it is hoped that serious knee injuries involving the cruciate ligaments will no longer be missed.

3.1 Basic Principles

3.1.1 Theoretical Principles

3.1.1.1 Planes and Axes of Motion, Translation and Rotation

Before we address the various theoretical and practical aspects of clinical laxity testing, it is useful to analyse the kinds of motion that can take place in the knee joint.

All knee movements are defined for the case where the tibia moves relative to the stationary femur. The movements are described in terms of three mutually perpendicular axes, the sagittal, transverse, and vertical, which run parallel to three mutually perpendicular planes, the transverse, frontal, and sagittal (Fig. 3-31). This three-dimensional system of axes and planes is not fixed in space but is constantly moving as a function of knee flexion, tibial rotation, applied forces, individual factors, and the condition of the capsule and ligaments.

Rotation is defined as movement around an axis, translation as the sliding of one surface over another on a plane parallel to the axis of orientation [57, 115]. In translation, then, the tibia slides beneath the stationary femur, moving parallel to itself in three-dimensional
space. One translational plane is assigned to each of the three spatial dimensions [42, 115] (for details see Sect. 12.4.2).

"Degree of freedom" is the term applied to the ability of a body to rotate around an axis or translate on a plane. Accordingly, there are three degrees of freedom in rotation and three in translation, for a total of six degrees of freedom:

Degrees of freedom in rotation (Fig. 3-1a)
1. Sagittal (anteroposterior) axis: abduction/adduction
2. Transverse (mediolateral) axis: flexion/extension
3. Vertical (proximodistal) axis: internal/external rotation

Degrees of freedom in translation
1. Transverse plane (motion parallel to the sagittal axis) (Fig. 3-1 b)
   anterior/posterior translation
2. Sagittal plane (motion parallel to the vertical axis) (Fig. 3-1 c)
   proximal translation (compression)/distal translation (distraction)
3. Frontal plane (motion parallel to the transverse axis) (Fig. 3-1 d)
   medial/lateral translation

3.1.1.2 Motion Spectrum

In examinations of the capsuloligamentous structures of the knee, it must be understood that the mechanisms of knee stabilization act not just in one joint position but in many. This is necessary to ensure that knee function will be adequate in all degrees of freedom and that it can adapt to changing loads. Consequently, evaluations of the anteroposterior and varus-valgus laxity of the knee should be performed in multiple positions of flexion and tibial rotation.

The normal range of knee motion about the transverse axis is from extension to 140° of flexion, and the normal range of tibial rotation is from about 30° of internal rotation to 30° of external rotation, the range of rotation varying with the degree of knee flexion. In theory an infinite number of joint positions may exist over these ranges of motion, each requiring its own pattern of stabilization by ligamentous structures. Thus, different structures are responsible for stabilization at small flexion angles than at large flexion angles. If we additionally consider the possible positions of internal and external rotation that are associated with different degrees of knee flexion, the

![Fig. 3-1a–d. Three-dimensional model of knee joint motion showing the axes of rotation (sagittal, transverse, vertical) and the planes of translation (transverse, sagittal, frontal) (a). Translation of the tibia take place on the transverse plane (b), the sagittal plane (c), and the frontal plane (d)]](image)