REFERENCES

1. **Goertzen MJ, Clahsen H, Bürrig KF, Schulitz K.-P.** Sterilisation of canine anterior cruciate allografts by gamma irradiation in argon: mechanical and neurohistological properties retained one year after transplantation. *J Bone Joint Surg [Br]* 1995;77-B:205-12.
2. **Halata Z, Haus J.** The ultrastructure of sensory nerve endings in human anterior cruciate ligament. *Anat Embryol* 1989;179:415-21.
3. **Goertzen M.** *Die allogene kreuzbandtransplantation als intraartikulärer bandersatz.* Aachen: Unas Verlag, 1992:57.
4. **Haus J, Halata Z, Refior HJ.** Propriozeption im vorderen kreuzband des menschlichen kniegelenkes – morphologische grundlagen: eine licht- raster- und transmissionselektronenmikroskopische studie. *Z Orthop* 1992;130:484-94.
5. **Goertzen MJ, Clahsen H, Bürrig KF, Schulitz K.-P.** Anterior cruciate ligament reconstruction using cryopreserved irradiated bone-ACL-bone allograft transplants. *Knee Surg Sports Traumatol Arthrosc* 1994; 2:150-7.
6. **Goertzen M, Gruber J, Dellmann A, Clahsen H, Schulitz K.-P.** Neurohistological findings after experimental anterior cruciate ligament allograft transplantation. *Arch Orthop Trauma Surg* 1992;111: 126-9.
7. **Goertzen M, Dellmann A, Gruber J, Clahsen H, Bürrig KF.** Anterior cruciate ligament allograft transplantation for intraarticular ligamentous reconstruction. *Arch Orthop Trauma Surg* 1992;111:273-9.
8. **Goertzen M, Dellmann A, Gruber J, Clahsen H, Bürrig KF.** Die homologe kreuzbandtransplantation als intraartikulärer bandersatz. *Z Orthop* 1993;131:178-86.
9. **Goertzen M, Gruber J, Dellmann A, Clahsen H, Schulitz K.-P.** Neurohistologische untersuchungen bei allogenen kreuzbandtransplantation als intraartikulärer bandersatz. *Z Orthop* 1993;131:420-4.

TOPIC FOR DEBATE

Taxonomy and treatment – a classification of fracture classifications

The reliability of classification of fractures has recently been the subject of discussion,[1-3] but reliability in itself does not measure the clinical usefulness of such systems. For example, fractures of the femoral shaft can be defined as type I in the right leg and type II in the left with complete reliability, but the distinction is trivial and has no clinical power. Müller et al[4] have stated that "a classification is useful only if it considers the severity of the bone lesion and serves as a basis for treatment and for the evaluation of the results".

We have devised a grading system for the classification of fractures based on this definition. This 'classification of classifications' assesses the degree to which the requirements of treatment can be based on the classification. In our assessment a grade-A system (Fig. 1) allows one-to-one pairing of its categories with particular regimes of treatment. The treatment of an injury is then a function of its assignment within the classification.

In our grade-B system, the criteria which define the classification are crucial factors in determining treatment, but they differ from the grade-A system in that the divisions are inappropriate and disrupt the direct relationship between classification and treatment. In a grade B-1 system (Fig. 2) the subdivisions are incomplete; two or more patterns of fracture, each having its own requirements for treatment, are inappropriately placed in the same category.

In a grade B-2 system (Fig. 3), there are excessive subdivisions, so that two or more categories share the same treatment. By contrast, our grade-C fracture system (Fig. 4) shows no relationship between the treatment and the category within the scheme. Many of these classifications serve only as shorthand terms for a topographical description.

We applied our rating system to 66 systems of classification collected from two textbooks on fractures.[5,6] When assessed as to the requirements for treatment 13 were grade A, 21 grade B (four B-1, 17 B-2), and 32 were grade C. Nearly half of the classifications had little relevance to a therapeutic plan. This was not necessarily a result of poor design; some had simply failed to evolve with changes in clinical practice. Advances in imaging had made some classifications obsolete; injuries grouped together on the basis of plain radiography may require CT or MRI to establish their full classification and subsequent treatment.

We recognise the problems created when a system of classification tries to serve simultaneously as both a clinical and a research tool. A system succinct enough for routine clinical use may be inadequate for research into outcomes.

J. Bernstein, MS, MD, Assistant Professor, Orthopaedic Surgery, Attending Surgeon, Department of Veterans' Affairs Hospital
B. A. Monaghan, MD, Resident, Orthopaedic Surgery (Retired)
J. S. Silber, MD, Resident, Orthopaedic Surgery
W. G. DeLong, MD, Adjunct Clinical Assistant Professor, Orthopaedic Surgery
Department of Orthopaedic Surgery, University of Pennsylvania School of Medicine, 424 Stemmler Hall, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6081, USA.

0301-620X/97/57177 $2.00
J Bone Joint Surg [Br] 1997;79-B:706-7.

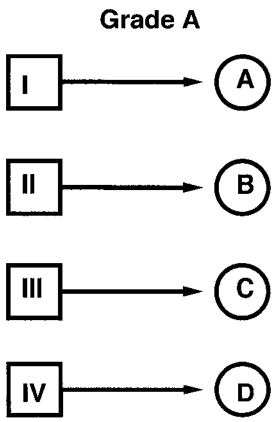

Fig. 1

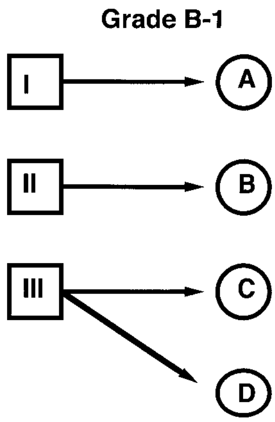

Fig. 2

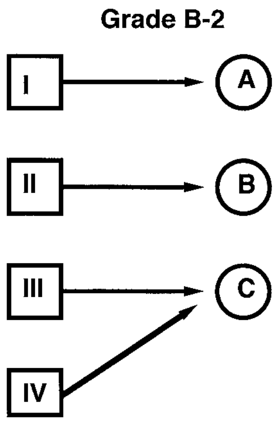

Fig. 3

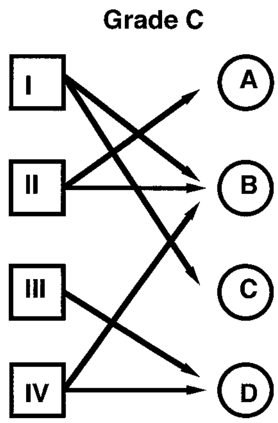

Fig. 4

Diagrams of relationships between categories (I to IV) and treatment (A to D). Figure 1 – In a grade-A clinical classification, each of the categories indicates a unique treatment. Figure 2 – In a grade B-1 classification, some categories contain two or more types of injury that should be treated uniquely. In this example, type-III fractures should be subdivided into those treated with treatment C and those treated with D. Figure 3 – In a grade B-2 classification excessive divisions are provided. Types III and IV are considered distinct, although both are treated similarly. For clinical purposes, these should form one new group III, which is treated by method C. Figure 4 – In a grade-C classification, the recommended treatment is not related to the category.

Conversely, a method which is detailed enough for research studies may be too complex for clinical use. Trafton[7] has previously noted that "a matrix of all, or even a moderate number, of selected factors [which affect outcome] produces a system that is too complex for clinical use".

Another consideration is that a complex research classification may not continue to serve for long as a grade-A clinical system: the new data which it collects may determine changes in the requirement for treatment. In this sense a research classification can contribute to its own demise as a clinical classification, and this limitation may apply to the AO classification system. The comprehensive nature of this system promotes the collection of more and more detailed data, but its use as a clinical tool has been criticised. "There is no prospective research to suggest that each of the expanded subgroups in the AO system correlates with important considerations of treatment."[3]

Such criticism is not completely destructive, but in many cases the AO system does not reach grade A. We recognise that factors which "correlate with important considerations of treatment" cannot be determined *a priori*. A grade-A system must be built from information on many factors, some of which may turn out to be critical; others will eventually be irrelevant. This need for completeness necessarily conflicts directly with the immediate needs of clinicians.

We therefore suggest that every fracture should be graded with two classification systems, one for clinical use and the other for research purposes. This will provide access to all of the data required for research without burdening the clinician with details which he cannot use. The AO classification of bony injury provides the basis for a general classification for research, but we believe that additional information should be included, such as the status of the soft tissues, the presence of associated non-skeletal injuries and the patient's medical history and age, all of which may influence the decisions for treatment for many fractures.

An ideal classification system[2] should be easily remembered and applied. It should show low variability between observers, offer clues about the mechanism of injury and pathoanatomy, facilitate the study of factors which influence outcome and group collections of similar lesions with unique needs for treatment. It may be impossible to satisfy all these requirements in a single system, but dual classification could meet most of these demands. The benefit of a 'cumbersome' research classification is the eventual creation of a powerful and relevant clinical classification. Both clinical and research categorisations are important for the optimal care of patients.

J. BERNSTEIN
B. A. MONAGHAN
J. S. SILBER
W. G. DeLONG

REFERENCES

1. **Bernstein J, Adler LM, Blank JE, et al.** Evaluation of the Neer system of classification of proximal humeral fractures with computerized tomographic scans and plain radiographs. *J Bone Joint Surg* 1996;78-A:1371-5.
2. **Burstein AH.** Editorial. Fracture classification systems: do they work and are they useful? *J Bone Joint Surg [Am]* 1993;75-A:1743-4.
3. **Kreder HJ, Hanel DP, McKee M, et al.** Consistency of AO fracture classification for the distal radius. *J Bone Joint Surg [Br]* 1996;78-B:726-31.
4. **Müller ME, Nazarian S, Koch P, Schatzker J.** *The comprehensive classification of fractures.* Berlin, Springer-Verlag, 1990.
5. **Rockwood CA, Green DP, Bucholz RW.** *Fractures in adults.* Philadelphia, etc: J. B. Lippincott, 1991.
6. **Browner BD, Jupiter JB, Levine AM, Trafton PG.** *Skeletal trauma.* Philadelphia, etc: W. B. Saunders Company, 1992.
7. **Trafton PG.** Tibial shaft fractures. In: Browner BD, Jupiter JB, Levine AM, Trafton PG. *Skeletal trauma.* Philadelphia, etc: W. B. Saunders Company, 1992:1771-85.