The Paradox of High Success

Our goal in studying principals of surgical technique is to achieve the highest possible rate of success. Yet the closer we come to this goal, the more difficult it becomes to perceive the result of our efforts. The reason for this is what I call the "paradox of high success " - the curious fact that, as success rates improve it becomes increasingly difficult to substantiate further improvements, because they become
- increasingly less apparent
- and increasingly difficult to prove.

The reason for the poor *perceptibility* of increment at high success levels stems from the practice of expressing success rates as percentages. However, the significance of a percentage change depends on whether it occurs at the middle or extreme end of the percentage scale. For example, a 10% improvement from 45% to 55% means very little because both rates imply that there is roughly one success for every failure. Thus the success rate (about 1 : 2) remains essentially unchanged despite the percentage improvement. In Contrast, an improvement from 80% to 90% means that, where formerly we could expect about 5 successes for every failure, we can now expect about 10. In this case then, the 10% improvement has led to a doubling of the success rate. Following this trend toward the extreme end of the scale, we will find that percentage improvements that appear negligibly small have a profound effect on the success rate. Thus, a rise of only 1% from 98% to 99% means that, where formerly we could expect 50 successes per failure, we can now expect about 100. A further improvement of only 0.5% beyond this point, from 99% to 99.5%, would be at risk for failure. It follows that success rates are more easily appreciated when they are expressed as fractions.

As the percentages rise, of course, there is a corresponding increase in the intellectual and material investment necessary to effect the improvement. Whereas little effort is needed to boost the rate from 45% to 55%, an increase from 80% to 90% calls for considerably greater know-how and technical expertise while an increase from 99% to 99.5% demands a tremendous investment indeed. The basic problem is that as success rates climb, it becomes increasingly difficult to justify the expense necessary for further improvements, since the improvement may not be amenable to statistical proof.

This brings us to part two of the "paradox of high success": the *unprovability* of extremely high success rates. The case numbers necessary for statistical proof increase dramatically with the success rate. For example, proof ($p<0.01$) that a success rate of 80% has been raised to 90% by a new technique would require a data base of 250 cases. Proof of improvement from 98% to 99% would require about 2900 cases and proof of a 99% to 99.5% increase would require about 5800 cases. Clearly, the case numbers necessary for a valid statistical study (one involving comparable patient populations, the same operator using a constant, standardized technique over the course of the study, and standardized follow-up procedures) cannot be achieved in practice. This implies that extremely high success rates cannot be proved.

It is important for the surgeon to understand the paradox of high success not just for his own motivation, but also so that he can discuss the problem intelligently with political and administrative authorities who make funding decisions. Obviously it is difficult to justify the enormous costs of increasing a high success rate when the improvement is neither numerically impressive nor provable.