(IV) Errors with Student's t test

The variance of the distribution of sample means is estimated from the data, and the precision of the estimate is reflected by the degrees of freedom associated with Student's t distribution.

When means are based on small samples the central limit theorem may not guarantee that the distribution of sample means is normal especially if observations are skewed. An example follows.

The length of stay in hospital is recorded to the nearest half day. Fig 1 shows the recorded length of stay for 20 patients in hospital A. The distribution is positively skewed. In fig 2 the distribution of the transformed variable $\log_e$ (length of stay), which follows more nearly a normal distribution, is shown. Assumption *a* (category IV in text) is approximately satisfied by the transformed response. Fig 3 shows $\log_e$ (length of stay) for 20 patients in hospital B. Within each hospital length of stay was recorded for 20 distinct patients and so assumption *b* is essentially satisfied. It is evident from figs 2 and 3 that the variance or spread of the observations on $\log_e$ (length of stay) is very different in the samples from hospitals A and B. Correction for heteroscedascity should not be ignored (assumption *c*).

The term "paired data" is explained in a further example.

Suppose that interest lies in comparing intraocular pressure before and after treatment in a random sample of patients with glaucoma. For each patient, the difference in pressure before and after treatment is calculated from the pair of observations on that patient. Student's 1-sample t test makes the relevant comparison between the sample mean difference and the zero difference that is expected if treatment has no effect on intraocular pressure.

(V) Errors with χ^2 tests

In a clinical trial 32 patients are assigned by simple randomisation to drugs A and B. Treatment success, defined as "discharge from hospital within three days of admission" is recorded for seven of the 15 patients randomised to drug A and for 14 of the 17 patients given drug B. The experimenter hypothesises that success rate is identical for both drugs and assesses by a χ^2 test whether the observed 14 successes

FIG 1—Hospital A. Skewed distribution of lengths of stay.

FIG 2—Hospital A. Distribution of transformed variable $\log_e$ (length of stay).

FIG 3—Hospital B. Distribution of $\log_e$ (length of stay).

on drug B out of 21 successes are consistent with that assumption. A correction for continuity is critical. The hypothesis that success rate is identical on both drugs is rejected at the 5% level, based on the uncorrected statistic ($\chi^2_1 = 4.5$), but only at the 10% level when the corrected statistic ($\chi^2_1 = 3.1$) is evaluated.

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Bone and Joint Diseases

Arthroscopy in practice

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The endoscopic examination of joints has been surprisingly slow to develop. The knee joint is particularly suitable for this technique because of the numerous mechanical derangements to which it is subject and also because arthrotomy does not always give adequate exposure owing to the intricacies of the joint's

anatomy. Tagaki of Japan was the first to use an arthroscope to examine the knee, in 1920. It was not until 1931, however, that a satisfactory instrument was finally developed. Since then there have been several reports of the use of the arthroscope, notably by Finklestein and Meyer in America and Hurter in France. Japanese workers have, however, shown the greatest ingenuity in the use of the arthroscope, culminating in the instrument devised by Watanabe in 1959. Jackson of Toronto, having worked with Watanabe, introduced the technique to North America and did much to stimulate interest in this technique in the Western world.

In Europe over the past decade there has been considerable interest in the procedure, resulting in many new designs of

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arthroscope. The most widely used instrument in Britain now is probably the Storz-Hopkins fibrelight instrument.

Indications

Internal derangements of the knee joint are an important clinical problem. The most commonly affected is the young active wage-earner. The future career of the competitive sportsman, either amateur or professional, may be jeopardised, and an incorrect diagnosis can lead to a wrong operative procedure being performed with disastrous permanent results.

The arthroscope's most important function is in elucidating these often difficult problems. In rheumatology direct inspection of the synovial membrane and visual sampling for biopsy is an important adjunct in the investigation and treatment of the various arthritides affecting the knee joint.

Technique

The examination is carried out under full aseptic precautions in the operating theatre. General anaesthesia is preferable so that complete muscle relaxation may be achieved to allow easy movement of the instrument within the joint. If only the synovium is being inspected and biopsied, however, local anaesthesia is adequate. After preliminary examination under general anaesthesia a tourniquet is applied around the upper thigh. The use of a tourniquet is not essential, but it does facilitate examination that may otherwise be made difficult by blood leaking into the joint cavity. Any effusion is aspirated, and through the same needle the joint is distended with 75-100 cc of physiological saline and connected to a continuous irrigation system.

The arthroscope is introduced through a small stab incision just lateral to the patella tendon immediately above the lateral tibial plateau. The interior of the joint is then inspected in an orderly manner starting with the suprapatellar pouch. The instrument is then slightly withdrawn until the articular surface of the patella comes into view and the entire patellofemoral articulation inspected. The knee is then flexed to about 60°, and the instrument is moved down across the medial femoral condyle so that the medial tibiofemoral compartment and the medial meniscus including its posterior horn are seen. The anterior cruciate ligament and the synovium in the intercondylar notch are next seen as the instrument is moved across the joint and lastly into the lateral compartment when the articular cartilage and the entire lateral meniscus are inspected. The posterior cruciate ligament is the sole intra-articular structure that cannot be adequately seen. At all stages photographic records may be taken through the arthroscope.

After the examination a dressing is applied to the stab incision, which is closed with one suture, and a crepe bandage is applied to the knee. On recovery from anaesthesia the patient may be allowed to walk, bearing his full weight on the affected leg. This examination may be performed on a day-case basis, the patient being allowed home the same evening to return in about 10 days for removal of the suture. No particular precaution is required in the immediate postoperative period, and the patient continues with his normal life. If some surgical procedure, such as meniscectomy, is necessary it may either be carried out under the same anaesthetic after redraping or else planned for a later date.

Complications

Arthroscopy appears to be trouble-free from the point of view of complications. I know of no septic arthritis that can be directly attributed to the use of the arthroscope and many reports have been published. It is probably wise, however, not to use this procedure within about three weeks of an intra-articular steroid injection because of the risk of infection that

this might entail. Occasionally haemarthrosis may occur. Minor degrees of scoring of articular cartilage may occur during the examination, but so far no long-term effects of this have been reported.

Accuracy

In experienced hands arthroscopy is an accurate diagnostic technique. Mistakes are most often caused by technical errors in inserting the instrument and by misinterpreting what is seen. Consistency of structures such as synovium and articular cartilage and hypermobility of menisci may be assessed by introducing a needle through the capsule into the field of vision from another site.

Undoubtedly it is an exacting technique needing considerable practice and expertise. There is no place for the self-taught occasional arthroscopist. Five errors in 121 cases of suspected meniscal disorders were reported by Jackson and Abe in 1972. In 1975 I reported a follow-up of 123 cases in which no lesion had been found at arthroscopy: in only three was the arthroscopic diagnosis eventually found to have been wrong. These figures contrast with those quoted for the accuracy of clinical diagnosis, a rate of error of 31.5% (Jackson and Abe) and 29.7% (Henry). Arthrography shows no improvement on clinical diagnosis: 31.8% (Jackson and Abe) and 32% (Klenerman and Butcher).

Advantages

The alternative to endoscopic examination of the knee joint is arthrography or visualisation through an open arthrotomy. In the knee joint arthroscopy has two main advantages. Firstly, all three compartments, the patellofemoral, medial, and lateral tibiofemoral can be inspected throughout including the posterior horns of the menisci. This latter is a blind area at open arthrotomy. Secondly, the postoperative morbidity is much less than after open arthrotomy, and the patient may get up immediately afterwards and in fact leave hospital the same day, which is probably not the case in most centres after arthrotomy.

It has been suggested that this is a time-consuming procedure that is difficult to undertake in the time allowed during a busy operating session. With practice, however, the technique need add no more than 10 minutes to the operation as a whole such as meniscectomy and, of course, if this prevents an incorrect procedure being performed the advantages are obvious.

Future developments

Possible future developments include perfecting an operating arthroscope akin to the operating cystoscope. This is already in production, but insufficient experience has accumulated for proper evaluation. Other joints such as the hip and shoulder have been investigated, but neither of these joints have been found satisfactory for arthroscopy. Being largely spherical, their articular surfaces are difficult to inspect, and also they are less affected by mechanical derangement than the knee joint.

Would the practice of marking a baby with a felt-tipped pen (Boki-pen) hold any danger for the baby?

I have no information about the Boki-pen, but there might well be a danger of the baby developing methaemoglobinemia if the ink contains aniline. If laundry marks are put on to nappies or other clothes after they have been boiled, instead of before, babies may absorb the aniline and become cyanosed. I have seen this happen, and there have been many recorded instances of it.