Insulin injection technique

Depth of injection is important

For many years after the introduction of insulin the recommended injection technique was to raise a skin fold and insert the needle at an angle of 45°. With the advent of shorter 12-13 mm needles these two instructions were no longer thought necessary; the belief was that a full depth perpendicular injection would allow consistent deposition of insulin into subcutaneous adipose tissue.[1] This technique is shown in educational material provided by the syringe manufacturers for patients and nurses and indeed is the recommended technique for use of the recently introduced and increasingly popular pen shaped injectors. Further support for the method recently appeared in the patients' magazine of the British Diabetic Association.[2] Nevertheless, evidence is increasing that the perpendicular technique may be far from ideal for many patients; it may be contributing to the variability of absorption that so impedes attempts to improve blood glucose control further.

Frid and Linden have shown by computed tomography that in non-obese patients the subcutaneous fat in the thigh and abdomen is often less than 10 mm thick.[3] This meant that patients using the recommended injection technique had been giving themselves painless intramuscular injections. In a further study that used computed tomography in non-obese patients similar results were found with a mean (SE) depth of adipose tissue in the upper lateral thigh of 5 (1) mm in men and 11 (2) mm in women, albeit in a relatively small number of patients.[4] Spraul *et al* showed with ultrasonography that the deltoid and abdominal subcutaneous fat layer was below 10 mm in all but two of 13 male volunteers, including some who were overweight.[5] It may be concluded, therefore, that many injections given by patients using the perpendicular injection technique will deposit insulin into muscle at least on an intermittent basis. Is this of clinical importance?

If the pharmacokinetic behaviour of injected insulin varies with the nature of the tissue into which it is deposited—that is, fat, muscle, or peritoneal cavity—then this would clearly be reflected in different rates of appearance of insulin in the blood and thereby in control of blood glucose. There have been conflicting conclusions from previous studies on the relative absorption rates of soluble (regular) insulin from subcutaneous and intramuscular injection sites, several showing no difference[6,7] and others showing more rapid absorption from muscle.[8,9] These earlier studies did not control for depth of injection by direct measurement of subcutaneous tissue, but some more recent work has used modern imaging techniques to allow accurate placement of the insulin. This has shown a 50% greater absorption of soluble insulin from an injection into a superficial thigh muscle when compared with injection into a subcutaneous site, but no such difference could be shown with injections into these two tissues in the abdomen.[4] In this study the insulin depots were placed by using computed tomography to control the depth of injection. In another study comparing the rates of absorption of soluble insulin after true subcutaneous, superficial intramuscular, and deep intramuscular injections ultrasonography was used to define tissue depths.[5] Similar results were found in that even superficial intramuscular injection resulted in more rapid absorption of the insulin.

The new evidence shows, then, that if insulin is injected accidentally and intermittently into the superficial layers of muscle this will contribute to day to day variability in the control of blood glucose. Furthermore, the true rate of absorption of soluble insulin from subcutaneous fat is slower and even more unphysiological than was previously thought. Thus the time for the plasma insulin concentration to reach its peak is about 60-80 minutes,[5] while the time to 50% absorption of an insulin depot as assessed by isotopic methods was greater than 180 minutes.[4]

Does the more rapid absorption of insulin from muscle confer a metabolic advantage over subcutaneous delivery? Theoretically hypoglycaemia excursions of the blood glucose at meal times and the risk of faster absorption would reduce between meals. Vaag *et al* recently showed more physiological absorption profiles at meal times with lower rates of absorption at five hours after injection when intramuscular injection was compared with true subcutaneous injection.[10] Perhaps of greater importance was their observation that there was less variability of blood glucose when it was monitored over a more prolonged period as evidenced by mean coefficients of variation of 33% after intramuscular injection and 43% after subcutaneous injection. But exercise had a greater potentiating and therefore unphysiological effect on intramuscular insulin absorption, an effect that must be of some concern if this route was used regularly by patients.

Less attention has been paid to the pharmacokinetics of the intermediate acting insulin preparations with respect to their rate of absorption from different tissues. This is somewhat surprising because as a group these preparations constitute more than 60% of all insulin prescribed and are the origin of much of the day to day variability in the rate of insulin absorption.[11] A recent study has shown that isophane insulin is more rapidly absorbed from muscle than from subcutaneous tissue and that variability from day to day and between patients was greater after intramuscular injection.[12] Overnight insulin absorption is often too rapid to provide adequate blood glucose control before breakfast, and thus true subcutaneous injection of isophane insulin results in an absorption profile that is better suited to providing overnight basal insulin delivery.[13] The coefficient of variation of the rate of absorption from subcutaneous tissue was lower than in previous studies at around 18%; possibly the lack of control for depth with resultant intermittent intramuscular injection may have been the cause of higher variability in past studies.[9] Clearly the intramuscular route cannot be recommended for the intermediate acting insulins.

Might pain from intramuscular injection mitigate against its long term clinical use? In practice this would seem not to be the case, at least in most patients. Patients in recent studies have noted almost uniformly that the superficial intramuscular route was no more uncomfortable than subcutaneous injection.[3,5] In addition it would seem likely that many diabetic patients have been unwittingly injecting intramuscularly for many years without recognised problems.[3]

So we need to re-evaluate the recommendations for insulin injection. In order to reduce variability of absorption and to provide an adequate basal insulin supply overnight the extended acting insulins should be injected at an angle into a raised skin fold. The currently available 12-13 mm needles would be acceptable for this purpose. On the basis of present evidence the deliberate injection of soluble insulin into muscle

cannot definitely be recommended despite the carrot of a more physiological action profile. Apart from the practical problems of assessing the depth of subcutaneous tissue in a large number of patients—and the provision of a range of needle lengths—longer term studies are needed on blood glucose control, the relative rate of hypoglycaemia, effects of exercise, and patient acceptability. Until such data are available it may perhaps be wise to recommend that soluble insulin is also injected at an angle into a skin fold or to provide shorter needles of 3-5 mm.

JONATHAN THOW
Clinical Research Fellow
PHILIP HOME
Consultant Physician and Senior Lecturer

Freeman Hospital,
University of Newcastle upon Tyne,
Newcastle upon Tyne NE7 7DN

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Emergency treatment of avulsed incisor teeth

Is simple but it needs to be prompt

The fall in the prevalence of dental caries in the past decade has been mirrored by an increase in the number of children and young adults with injuries to their teeth.[1] A greater understanding of the factors affecting the prognosis after dental injuries, together with improvements in restorative materials and techniques, has led to many teeth being saved that once would have been lost. In the case of completely avulsed teeth, however, prompt action is needed to preserve and reposition a tooth if it is to be successfully reimplanted.[2] This task often falls to casualty officers.

An avulsed tooth should be replanted within its socket as soon as possible and then stabilised until the gingival and periodontal tissues can be repaired. After an hour outside the socket a tooth that has been allowed to get dry has a poor chance of successful reimplantation because the cells on the root surface that are necessary for reattachment start to die. If immediate reimplantation is not possible the prognosis can be improved by careful storage. For up to an hour the vitality of the cement can be maintained by wrapping the tooth in plastic foil.[3] For longer than that cell viability can be sustained by storing the tooth in milk, which has an osmolarity and pH (230-270 mmol/kg and 6·6) compatible with cell survival.[4]

Reimplantation is carried out by rinsing the tooth gently in saline and placing it in the socket, taking care to handle it by the crown. Gentle pressure will allow the tooth to be seated in the socket without pain. If shown how, many children will replant the tooth themselves. Temporary stabilisation with aluminium foil or with histoacryl tissue adhesive, as described by McCabe on p 20, will hold the tooth in place until definitive dental treatment can be given. Avulsed teeth need to remain splinted for about 14-21 days.

The major cause of tooth loss after reimplantation is resorption of the tooth root accompanied by inflammation or ankylosis. The tooth socket wall is continually being remodelled in response to functional demands, and the cement on the root surface tends to thicken with age. After avulsion pathological resorption often occurs on the root surface, the cement being replaced by granulation tissue or bone. Under ideal conditions, when injury to the root surface is minimal, repair of the periodontal membrane may occur within 14 days. The state of the pulp is also critical in root resorption, and in young children whose roots are not fully developed early replantation enables the pulp to recover.

The prognosis is improved by using ampicillin after replantation as control of bacterial invasion into the injured tissues will prevent inflammatory resorption.[5] Gingival healing is also important, so 2% chlorhexidine mouth rinse should be used twice or three times daily to reduce the accumulation of plaque. The patient may also need an antitetanus toxoid booster, particularly if the injury occurred out of doors. Finally, the patient, with his or her replanted and stabilised tooth, should be referred to a dentist for further care as soon as possible.

BARRY SCHEER

Lecturer in Paediatric Dentistry,
Department of Child Dental Health,
London Hospital Medical College,
London E1 2AD

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Correction

Late onset asthma

A printer's error occurred in this editorial by Mr Jon G Ayres (23 June, p 1602). In the eighth line of the fifth paragraph the drugs referred to are β blockers and not Hgb blockers as published.