and a Schilling test revealed an absorption in part I of less than 5%, rising to 19·5% after addition of intrinsic factor. Cerebrospinal fluid examination was normal.

Motor and sensory conduction studies in the upper and lower limbs were normal apart from an absent right sural sensory action potential. Somatosensory evoked responses (SSEP) were measured following median nerve stimulation. N9, N13 and N20 responses were assessed on admission, and after two, five and twelve months of replacement therapy. Treatment with hydroxycobalamin produced symptomatic improvement. His sensory symptoms disappeared and by three months he was walking unaided, though his gait remained spastic and ataxic. The spasticity lessened thereafter and by six months he had returned to work. After one year, joint position sense loss in the feet was minimal and both ankle jerks were obtainable.

Studies of both peripheral and central conduction studies have been performed in patients with pernicious anaemia. There have been four previous analyses of somatosensory evoked potentials in sub acute combined degeneration of the spinal cord.[1-4] In the first, three patients were studied.[2] In addition to measurement of peripheral nerve conduction, and F responses, N9 and N1 (N20) were recorded. The F responses and the N9 latencies were either slightly prolonged or at the upper limit of normal. N1 (N20) latencies, on the other hand, were significantly delayed with values between 22 and 23 ms, compared to values of less than 19 ms in control subjects. The findings were interpreted as representing the consequent of severe demyelination in the posterior columns of the spinal cord with slight axonal loss in the peripheral nerves. The second paper on the subject assessed seven patients, though only two of these had substantial neurological involvement.[3] Median somatosensory responses were normal in all of them but two (those neurologically affected) had absent peroneal responses which reappeared on testing. No values for somatosensory responses at this time were given. In the third paper,[4] concerning two patients, somatosensory evoked potentials with median nerve stimulation were normal, but those elicited by peroneal nerve stimulation revealed prolonged central conduction times. Peripheral sensory and motor nerve action potentials were reduced with normal or slightly reduced conduction velocities. The authors postulated that the main pathological change in the central nervous system might be demyelination in the posterior columns in addition to axonal degeneration in the peripheral nerve. In the fourth paper on the subject,[1] which reports similar results to our own, electrophysiological testing was performed on a 72 year old lady with pernicious anaemia 6 weeks after the onset of symptoms and subsequently after 9 months treatment. Peripheral nerve conduction studies were normal throughout. The somatosensory cortical responses N20, P25 and P40, following right median nerve stimulation, were markedly delayed but shortened in latency after nine months Vitamin B12 therapy.

In our patient, there were abnormalities of central conduction (absent N13 and delayed N20) following stimulation of the median nerve, tests of peripheral conduction in which had been normal. The initial improvement in the SSEPs, the reappearance of N13, was noted five months after starting therapy. The N20 potential remained delayed with the retest seven months later. The further shortening of these latencies, between five and twelve months after the initiation of therapy, was mirrored by improvement in the patients' neurological status.

Our findings and those of others indicate that in sub acute combined degeneration, altered somatosensory responses are a sensitive index of the presence of pathological changes in the sensory pathway. The predominant abnormality and later recovery, of the N20 responses reflect the known tendency for pathological change to centre on the dorsal columns.

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Elastic properties of muscle measured at the elbow in man. Defining velocity sensitive resistance to passive movement in a clinically measurable manner.

Sir: Normal muscle "tone" does not normally depend on neural mechanisms. The resistance to passive movement should theoretically represent mechanical factors only,[1] and those factors should not change even with anaesthesia.[2] Yet velocity controlled movement does have a threshold where neural effects can be seen in normals and these effects together with complex resistances cloud the separation of the normal and spastic individual.

Wiegner *et al* have solved a number of problems defining the elastic or position sensitive component of the resistance to passive motion.[3] The elastic components can be demonstrated by observing the forces at slow velocities well below the threshold of reflex activation, thus providing important information about intrinsic changes within the morphology of the muscle. While the authors appropriately apply the method to the rigidity of Parkinsonism,[4] they also recommend this tool for objective assessment of spasticity.[3] These authors report 0·014, SD 0·0294 NM/deg. compliance for the elbow in the mid-range of movement, almost identical with that found by others. As a practical matter, with certain assumptions, the effect of spasticity may be objectively demonstrated in a far simpler manner. Spasticity can be defined as the velocity sensitive resistance to passive movement.[6] If the elbow is passively oscillated at faster and faster velocities, the elastic components (even in normal subjects) are relatively insignificant compared with the viscous and inertial effects. A passive constant-velocity dynamometer that is available in the clinic that includes a built-in dual channel EMG can be used as an effective tool.[7] Hill has suggested that taking velocity as the independent variable has the advantage of "better definition of length-tension curve particularly at the end of the curve with the higher velocities".[8] Also if the muscle fibre were excited, "the fibre would not have to move anything except itself".[8]

Relationship between area of passive length-tension curve and velocity. The velocity sen-

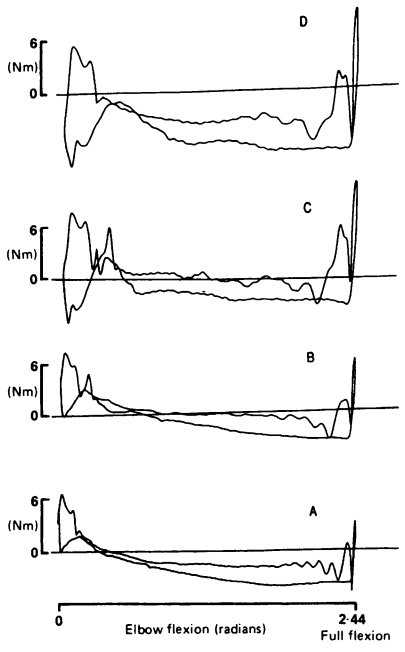

Fig 1 *Length-tension plots of torque versus elbow flexion at 1·57, 2·09, 2·62 and 3·89 radians/s (A to D respectively) in a 46 year old healthy subject. Passive movements were continuous and oscillatory in which both extension and flexion were at the same velocity.*

sitive effects are the viscous forces as shown here in a 46 year old subject (fig 1) and can be represented by the progression in force-velocity areas (fig 2). We have found in an environment where acceleration is known and velocity is controlled during the motion, a highly linear increase in area with respect to velocity. And this effect is reproducible. It seems unreasonable to attribute the neural or reflex effect seen in the added force levels above 120°/s to changes in elasticity. This normal linear function (r = 0·99) from 90–220°/s represents a progression that includes the lumping of visco-elastic and inertial effects. But because limb mass and moment of inertia do not change, gravity correction is not necessary and qualitative statements can be made about the resistance to passive movements. This relationship is supported by earlier work in which a consistent linear relationship was found between reflex EMG and the velocity of stretch in the biceps over a wide range of velocities (0–500°/s).[9]

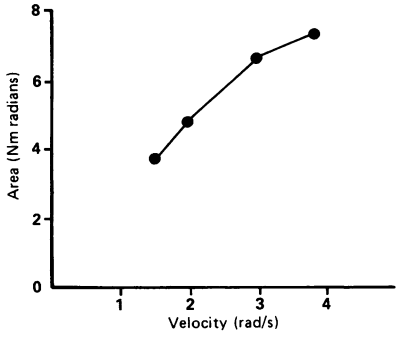

Fig 2 *The relationship between the areas inscribed within the length-tension loop and the velocities of the passive movement.*

Advantages of this approach. Limiting measurement interval and overall time for patient assessment has been shown to be critical.[10] This procedure requires one sitting for a period of about 10 minutes. Predominately elastic changes can be estimated at velocities below reflex threshold, and as velocity is increased, the velocity threshold for reflex EMG can be detected. Since short term EMG events do not correlate well with torque output, the added viscous effects caused by heightened neural reflexes will alter the slope of area vs. velocity relationship from a straight line function when a velocity threshold is present.

Disadvantages. As yet we do not have a way to subtract the area's due to inertial effects without an estimate of the centre of gravity of the extremity.[11] The patient's tolerance of higher velocities of oscillating motion is less than linear motion at the same velocities. It is also harder for the patient to relax. These combined effects cause the measurement error to increase when compared to linear movement.

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Blood brain barrier permeability in multiple sclerosis using labelled DTPA with PET, CT and MRI

Sir: Pozzili *et al* recently reported on the measurement of blood brain barrier (BBB) permeability in multiple sclerosis (MS) using 68-Ga-EDTA and positron emission tomography (PET).[1] Their paper, however, contains some numerical inconsistencies and in addition the permeability measured is much smaller than that indicated by our MRI studies for the reasons discussed below.

In their summary the authors quote a blood to brain influx constant K_i for Gallium-EDTA of 12·5 ml $g^{-1}min^{-1}$ in multiple sclerosis patients with a clinical exacerbation of their disease, and a K_i of 3·2 ml g^{-1} min^{-1} for normal tissue. The measurements of multiple sclerosis were made in areas of the brain judged abnormal by high volume delayed CT scanning (HVD-CT). These values are clearly too high and contradict their table 3 which shows $K_i = 12{\cdot}5 \times 10^{-4}$ ml $g^{-1}min^{-1}$ for multiple sclerosis patients and $3{\cdot}2 \times 10^{-4}$ ml $g^{-1}min^{-1}$ for normal controls. Tables 3 and 4 also show for normal and multiple sclerosis brain the plasma volume (V_p) in the range 3·3–4·5 ml g^{-1}. These values are clearly impossible since even pure blood contains only about 0·55 ml g^{-1} of plasma, and normal white matter only about 0·02 ml g^{-1} of blood.[2]

The authors found BBB permeability in