Wound healing after total elbow replacement in rheumatoid arthritis

Wound complications in 50 cases and laser-Doppler imaging of skin microcirculation

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Wound healing complications, predisposing to deep infection, are common following prosthetic surgery of the elbow. 50 capitellocondylar elbow prostheses were inserted, using a lateral approach, in 42 patients with rheumatoid arthritis. The first 5 elbows were immobilized postoperatively for 5 days and the following 45 elbows for 12 days, because of delayed wound healing in 2 of the first 5 elbows. No wound healing complications were recorded in elbows immobilized for 12 days and elbow motion was not compromised. 5 elbows were investigated with laser-Doppler imaging (LDI) technique, both pre- and postoperatively. Postoperative LDI values were considerably higher than preoperative ones, indicating no impairment of local skin microcirculation. The authors conclude that the lateral approach is safe to use in prosthetic surgery on the elbow. Early mobilization can delay wound healing, but this can be prevented by 2 weeks of postoperative immobilization.

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In prosthetic surgery of the elbow, retrospective evaluations have found wound healing complications in up to one third of the cases (Souter 1973, Rydholm et al. 1984). Impaired wound healing probably predisposes to deep infection (Roper et al. 1986, Ruth and Wilde 1992) which is a major problem, with an incidence ranging from 1 to 9 percent (Morrey and Bryan 1983, Ewald et al. 1993). One reason for wound healing problems may be an insufficient blood flow in the wound margins caused by an incorrect skin incision and extensive soft tissue dissection.

Laser-Doppler flowmetry (LDF) is an established method for monitoring skin microcirculation (Johnson et al. 1984, Svensson and Jönsson 1987), but the standard LDF probe covers an area of only about 1 mm^2 (Tenland et al. 1983, Svensson et al. 1992). This limitation can be overcome by performing a scanning procedure, for which laser-Doppler imagers have recently been constructed (Essex and Byrne 1991, Wårdell et al. 1993). The mean flow values from larger areas that can thus be calculated are of clinical value (Bornmyr et al. 1994).

We ascertained prospectively the incidence of wound healing complications and deep infection in a consecutive series of 42 patients who had received 50 capitellocondylar total elbow prostheses via a lateral approach. The skin microcirculation in the wound margins was studied by the laser-Doppler imaging (LDI) technique pre- and postoperatively in 5 patients to ascertain the possible influence of a compromised blood flow on the wound healing process.

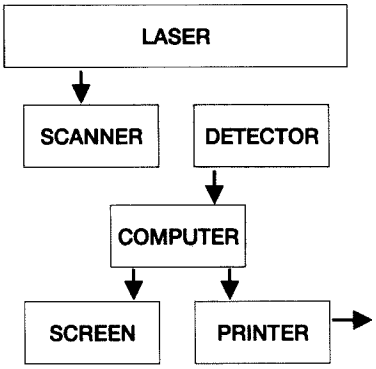
Material and methods

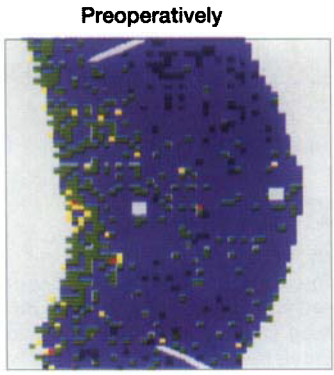
Patients

Between 1989 and 1993, 42 patients (4 men, 38 women) with a median age of 62 (25–80) years underwent 50 total elbow replacements with the capitellocondylar elbow prosthesis at the Department of Orthopedics in Lund. 16 elbows had previously undergone surgery with 17 synovectomies and 2 interpositional arthroplasties (3 elbows had been operated on twice). 38 patients had rheumatoid arthritis (RA) and 4 had juvenile chronic arthritis (JCA) with a median disease duration of 22 (3–46) years. All elbows were followed up prospectively at 4 months and then yearly. Complications were recorded prospectively.

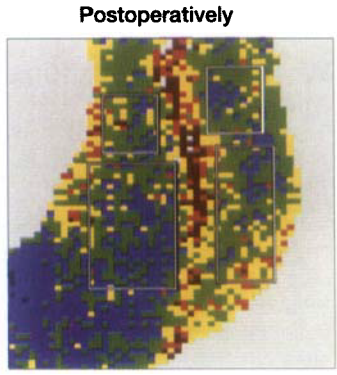
The LDI technique was introduced at the Department of Clinical Physiology in Malmö in March 1992. Since then, 20 elbow replacements have been

Figure 1. Block diagram of the laser-Doppler imager and sample images.





Preoperatively, aniline marks, representing the lateral epicondyle, the olecranon and the endpoints of the planned incision line, are identified in the image. Different colors in a scale from dark blue to red represent increasing blood flow values.



Postoperatively, the incision line with its sutures, is identified and rectangular areas for blood flow calculation are marked anterior and posterior to the skin incision, in some instances two areas on the same side. Nearby pixels show wide variation in blood flow values.

performed in 20 patients and they were thus candidates for investigation with LDI. 13 patients could not be studied due to general disability making transportation impractical, leaving 7 patients for investigation with LDI, which was performed 1 day pre- and 2 days postoperatively. The first case had to be excluded because of technical difficulties. 1 patient refused the second investigation because of postoperative pain. Measurements from 5 elbows in 5 women with a median age of 52 (30–68) years remained for evaluation. 3 of these elbows had previously been operated on with 4 synovectomies. 4 patients had RA and 1 JCA with a median disease duration of 23 (3–35) years. Of these 5 patients, 2 were receiving steroids and 1 was also taking methotrexate.

Controls

5 healthy female volunteers were investigated with LDI. Their median age was 56 (50–61) years. None of them was a smoker or was taking any medication.

Operative procedure

A lateral Kocher approach modified according to Ewald was used in all cases (Ewald and Jacobs 1984). The incision line was placed between the lateral epicondyle and the olecranon. When previous surgery had been done via a lateral approach, the scar was included in the new incision. A bloodless field was ensured by applying a tourniquet. Median tourniquet time was 128 (90–159) min and median tourniquet pressure was 220 (180–300) mmHg. In the 5 elbows investigated with LDI, median tourniquet time was 105 (102–127) min and median tourniquet pressure was 200 (185–250) mmHg. The first 5 elbows were immobilized postoperatively for 5 days in a plaster slab at an angle of approximately 70° of flexion. As there were 2 cases of delayed wound healing, the postoperative regime was altered for the remainder of the elbows which were immobilized for 12 days in the same position.

Laser-Doppler imaging

The device used in our study consisted of a scanner system, a laser light source and a photo diode detector (Figure 1). All measurements were performed at a constant room temperature of 23 ± 1 °C. Conversation was avoided. 15 min were allowed for acclimatization. During measurements, the patient sat comfortably with the arm resting on an adjustable table. Preoperatively, the endpoints of the planned incision line, the lateral epicondyle and the olecranon, were all marked with an aniline pen. The measuring head of the scanner was placed perpendicular to and 20 cm above this surface. The light in the room was dimmed to avoid interference with signal detection. Both elbows were scanned at 50°, 70°, and 90° of flexion preoperatively. Postoperatively, the measurements were repeated, but the contralateral elbow was measured only at 70°. The measuring procedure in controls was the same as the preoperative investigation in patients. Each scanning took 3–4 min to perform. During the scanning procedure, measurements from a maximum of 4,096 points, corresponding to

an area of 12 × 12 cm, were obtained, computer processed and stored as arbitrary perfusion units (LDI-PU). Images in which different colors represent different flow values were subsequently built up and, in these images, areas for blood flow calculation were marked anterior and posterior to the skin incision (Figure 1). Mean values of LDI-PU were calculated from these areas. Local perfusion defects were sought in postoperative images.

Results

Delayed wound healing was recorded in 2 of the first 5 elbows, postoperatively immobilized for 5 days. Both wounds were normal at the beginning of mobilization, but had small central defects after 2 weeks, without any signs of infection. Both elbows healed after secondary wound suture. There were no wound healing complications among the subsequent 45 elbows, immobilized for 12 days. The only case of infection was hematogenous, occurring 1 year postoperatively in a patient whose rheumatoid vasculitis became worse, requiring treatment with high doses of steroids and cytostatics. Another patient fell on her arm a few days postoperatively, sustaining a wound rupture and a prosthetic dislocation. These complications were not considered relevant in the present study of wound healing complications. Median flexion was 145 (125–155)°, with a median extension deficit of 35 (15–70)° 4 months postoperatively, and 1 year postoperatively median flexion was 145 (125–155)°, with a median extension deficit of 30 (5–80)°.

Initial recordings in patients and controls showed no differences in LDI values between their 2 elbows, but values in patients were higher than in controls. Preoperative LDI values were slightly higher posterior to than anterior to the incision line and this difference was more pronounced postoperatively. Postoperative LDI values were considerably higher than preoperative ones. There was no difference in values before and after operation in the contralateral elbow (Figure 2). There was no difference in LDI values obtained at different degrees of elbow flexion. No local perfusion defects were detected in the images.

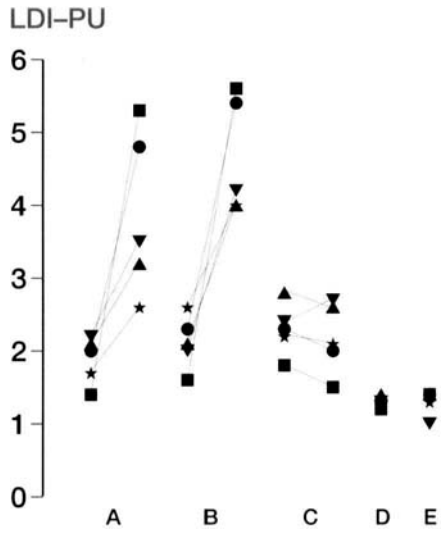


Figure 2. Pre- and postoperative LDI in total elbow replacement, anterior (A) and posterior (B) to the incision, and in the contralateral elbow (C) of 5 rheumatoid patients, compared to LDI in the right (D) and left (E) elbows of 5 healthy controls, all measurements performed at 70° of elbow flexion.
PU perfusion units.

Discussion

The incidence of wound healing complications after total elbow replacement is difficult to estimate, since most series are small and retrospective. Retrospective recording of complications tends to underestimate the true incidence of postoperative complications, especially minor complications. A recent report suggests that postoperative complications are less frequent after a lateral approach than after a posterior approach (Ewald et al. 1993). In that report on 202 capitellocondylar total elbow replacements, the posterior approach was used in the first 82, and the lateral approach subsequently. There were 8 (10 percent) wound healing complications in the first group and 7 (6 percent) in the second, an insignificant difference. We used a lateral approach and wound healing complications, prospectively recorded, occurred in 2 out of 50 elbows (4 percent).

Postoperative immobilization has been reported to prevent wound healing complications after total elbow replacement (Maloney and Schurman 1989, Brady and Quinlan 1993). In our study, no wound healing complications were seen in the 45 elbows immobilized postoperatively for 12 days, but 2 cases of delayed wound healing were recorded in the 5 elbows immobilized for only 5 days. However, other factors than the shorter postoperative immobilization time, such as the surgeons' learning curve, may have been of importance for the incidence of our 2 cases of wound complications. Nevertheless, the absence of wound complications in the 45 elbows immobilized for 12 days indicates that immobilization during wound healing is of importance in preventing healing problems and thereby infections. The postop-

erative range of motion was not compromised by the postoperative regime. We believe that 2 weeks of immobilization is sufficient to prevent healing complications.

With LDI, we observed no signs of impaired circulation in the wound margins. Obviously, the rather extensive soft tissue dissection used in the lateral approach to the elbow does not compromise the circulation in the wound margins. Values did not differ at 50°, 70°, and 90° of elbow flexion, indicating that the degree of elbow flexion during postoperative immobilization is not critical for local blood flow. The LDI values were slightly lower in the anterior than in the posterior wound margin, but there was an obvious hyperemic reaction in both wound margins postoperatively, which is expected from a physiological point of view in a situation of normal wound healing. In our opinion, the postoperative increase in skin blood flow is primarily a part of the inflammatory response of the healing process, but an increase in deep tissue temperature may contribute.

Our findings contradict previous observations made when using transcutaneous oxygen tension in the knee. Following knee replacement, transcutaneous skin oxygen tension measurements showed reduced wound oxygenation, the lateral wound margin being less well oxygenated than the medial margin, with no difference between different incisions (Johnson 1988). Early mobilization with continuous passive motion of the knee (knee flexion beyond 40° during the first 3 days) further reduced oxygen tension in the lateral wound margin (Johnson 1990). The relation between transcutaneously measured oxygen tension and skin blood flow is not clear, however. Since the skin vessels under the isothermically heated (44 °C) oxygen sensor are dilated, they do not respond to vasoconstrictor stimuli and therefore behave passively (Fagrell et al. 1982). Following surgical trauma with ensuing inflammatory response, the vasoconstrictor tone is released even beyond the measuring area. Local skin blood flow is thus evenly distributed, without preference for the oxygen probe area. The increased blood flow also tends to conduct heat from the probe. Both of these effects may reduce the oxygen tension values obtained (Svedman et al 1982), rendering postoperative transcutaneous oxygen tension values, as a measure of skin viability, uncertain.

LDI values obtained from the rheumatoid elbows preoperatively were higher than those obtained from the healthy elbows in our study. The obvious cause is an increased skin blood flow elicited by the underlying synovitis of the rheumatoid elbow joint. In a study by Singer et al. (1994), LDF values from the prepatellar skin of rheumatoid patients were the same or lower, compared to healthy controls. The difference can be explained by the fact that measurements in the knee were made in a skin area overlying the patella and not in a skin area overlying the synovial membrane, as in our study.

In conclusion, laser-Doppler imaging, in selected cases, showed no evidence of impaired skin microcirculation in the wound margins following total elbow replacement via the lateral approach. Furthermore, the incidence of wound healing complications, recorded prospectively after 2 weeks of immobilization, was low. We suggest that, with the use of the lateral approach and 2 weeks of postoperative immobilization in prosthetic surgery of the rheumatoid elbow, a low incidence of wound healing complications, and hence infections, can be expected.

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