Table 1: Relationship of operations performed to the site of metastses

	Proximal humerus	Midshaft humerus	Distal humerus	Clavicle	Scapula	Total
Intramedullary rod	14	37	0	0	0	51
Plate and screws	0	2	6	1	0	9
Resection & prosthesis	22	2	4	0	2	30
Resection alone	2	0	0	1	1	4
Amputation	1	1	0	0	0	2
						96

Presenting symptoms

Pathologic fracture was the commonest presentation (52 patients, 56%). Pain without fracture was the main presenting complaint in 41% of cases. Only 2 patients presented with a painless lump in the arm.

Tumour type and location

Breast carcinoma was the commonest histotype with almost 25% of patients presenting with this diagnosis. Myeloma, renal and lung carcinoma were the next most common diagnoses (Figure 1). Almost 90% of tumors were located in the diaphyseal (middle third) or proximal (proximal third) humerus (47% and 42% respectively). Distal humeral (distal third) metastases were uncommon, with 11% involvement. Scapular and clavicle involvement was rare (4% and 2% respectively)

Surgery

The most common procedure was the insertion of a rigid intramedullary rod and the second most common procedure was resection of the metastatic lesion and prosthetic reconstruction (Table 1). Plate osteosynthesis was predominantly used for diaphyseal and distal humeral lesions. The location of the tumor in the humerus was a significant determinant of the type of operative procedure performed.

Intramedullary nailing was performed in 51 cases mainly for diaphyseal lesions and in some proximal lesions where there was sufficient normal proximal bone for the rod to span. The Alta intramedullary rod (Stryker Howmedica Osteonics, Mahwah, NJ) with methylmethacrylate bone cement (Edurance, DePuy, Warsaw, IN) was used in 44 cases. The Alta rod was chosen because of its fluted design which allows backflow of cement on insertion (Figure 2). 4 cases used the Fixion inflatable rod (Disc-O-Tech Medical Technologies, Herzliya, Israel). The remaining 3 cases each utilized another type of rigid intramedullary rod with interlocking screws. The choice of rod used was determined by the operating surgeon. 8 cases were done via an open technique, with curettage of the tumor cavity and reduction of the fracture. The open technique was used if the fracture was unable to be reduced closed (due to comminution or marked displacement) or if the fracture or bone defect is adjacent to the path of the radial nerve as it winds posterior around the humeral shaft. By formally exposing the fracture, the nerve is able to be protected from potential cement injury and good alignment of the fracture can be maintained when inserting the rod and curing of the cement.

Prior to insertion of the intramedullary rod, the humeral canal was reamed and irrigated. A suction catheter was placed in the canal and low viscosity cement with Gentamycin antibiotic (Endurance, DePuy, Warsaw, IN) was injected into the proximal entry hole. The intramedullary rod was inserted while the cement was still wet in order to reduce the risk of pulmonary embolic phenomenon [5,6].

Recognizing that the tumors were metastatic carcinomas, and in all cases, treatment was for palliation, the aim of surgical margins when inserting a prostheses was to preserve as much bone as was reasonably possible and also to preserve and reconstruct the rotator cuff. A variety of prostheses were used with cementation of the stem to the shaft. Proximal prostheses were used if there was involvement of the humeral head or insufficient healthy bone to allow proximal purchase of an intramedullary rod. There were 20 Isoelastic proximal humeral replacements (Mathys, Bettlach, Switzerland) and 2 Neer II (Smith and Nephew, Mansfield, MA) prostheses. Not all of the proximal humeral prostheses have the facility to repair the residual rotator cuff to the prosthesis. If suture holes are available to reconstruct the capsule or rotator cuff to the prosthesis, then this should be done to enable greater stability at the shoulder. If no suture holes are available, then nylon mesh fixed around the proximal part of the prosthesis can be used as a reliable anchoring site onto which capsular or rotator cuff fixation may be performed. Stabilizing the shoulder allows more useful function of the hand and elbow, and decreases the "dragging sensation" that some patients experience with inferiorly subluxing prostheses.

2 intercalary prostheses were used for diaphyseal lesions. Distal lesions treated with prosthetic reconstructions used a total elbow replacement system (Zimmer, Warsaw, IN). Scapular lesions were treated with scapulectomy in con-