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Synchronous Fractures of the Trochlea and the Radial Neck without Elbow Dislocation

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Fractures of the articular surface of the distal end of the humerus (i.e., of the capitellum and the trochlea) are rather uncommon injuries. Fractures of the capitellum account for 1% of all elbow fractures and about 6% of all distal humeral fractures.[1] Fractures of the trochlea are usually encountered as part of more complex intra-articular fractures of the distal end of the humerus, disrupting the medial and/or the lateral column of the humerus.[2,3] Isolated fractures of the articular surface of the trochlea are very infrequent and are sporadically encountered in the literature as case reports, thus there are only a few clinical series dealing with the description and the surgical treatment of this injury.[3–11] Trochlear fractures usually accompany elbow dislocations[5,6] or type IV fractures of the capitellum.[12,13] Unusual complex injuries about the elbow joint that combine fractures and ligamentous disruptions may be difficult to diagnose and treat. The combination of a ligamentous injury and an intra-articular fracture increases the severity of the injury. Simple elbow dislocations where all ligaments are disrupted have a favorable prognosis when treated conservatively, in contrast to complex dislocations that are combined with fractures and that may require surgical intervention to obtain joint stability.[14–16]

We present an unusual case with concomitant, distinct fractures of the trochlea and the radial neck, accompanied by medial collateral ligament (MCL) disruption, caused probably by a combination of injury mechanisms. Our literature review revealed no other similar case.

CASE REPORT

A 33-year-old, right-hand-dominant male motorcyclist was involved in a high-speed motor vehicle crash in June 1997. He fell from his motorcycle and landed on his outstretched hand. He immediately experienced severe pain in his left elbow, although he was able to move the joint to some extent. He suffered no other injuries and did not lose consciousness. He did not report any gross deformation of the elbow or any sensation of dislocation and automatic relocation. The left upper extremity was splinted by the paramedics and the patient was transferred to the hospital. At the time of presentation to the hospital, the patient's elbow exhibited swelling and was painful. On clinical examination, edema and ecchymosis were evident on both the medial and the lateral surface of the elbow. The patient resisted flexion and extension of the elbow because of pain. The forearm rotation was also painful, although almost full pronation and supination were possible. No attempt was made to detect crepitus over the joint line. Point tenderness was noted at the radial head, along with pain in pronation and supination and at the medial aspect of the elbow. The joint showed valgus laxity on manual stress testing. The neurovascular examination of the upper extremity was unremarkable. On the anteroposterior and lateral radiographs of the elbow, fractures of the trochlea and the radial neck were evident, without elbow dislocation (Fig. 1). The trochlear fracture was not visible on the lateral film but only on the anteroposterior film. The radiocapitellar line was preserved. The fracture of the trochlea extended to the medial ridge, displacing it and disrupting the articular surface. The radial neck was fractured as well in an oblique subcapital fashion, without significant translation or angulation. No free osteochondral fragments were evident in the joint. The decision for open reduction and internal fixation was made to restore the articular surface of the ulnohumeral joint, to allow early joint motion as early as possible, and to restore the ulnar collateral ligament. The patient was brought to the operating suite and placed on the operating table in a supine position. After suitable endotracheal anesthesia had been administered, the patient was turned to the lateral decubitus position, and the arm was prepared and draped in a normal sterile manner. A sterile pneumatic tourniquet was applied. The elbow joint was approached through a posterior midline incision, raising full-thickness fasciocutaneous flaps. After limited elevation of the anconeus muscle, a chevron osteotomy was started at the nonarticular transverse groove of the trochlear notch of the ulna with a thin oscillating saw and completed with an osteotome. This approach was chosen because it allows simultaneous exposure of the trochlea and the radial head. The proximal part of the olecranon was elevated proximally with the triceps, exposing thus the trochlear fracture. The fracture line displayed a T configuration (Fig. 2). The principal line divided the trochlear sulcus in the sagittal plane. A secondary fracture line ran in the coronal plane and divided the lateral ridge in two segments, one anterior and one posterior. The fracture was reduced and

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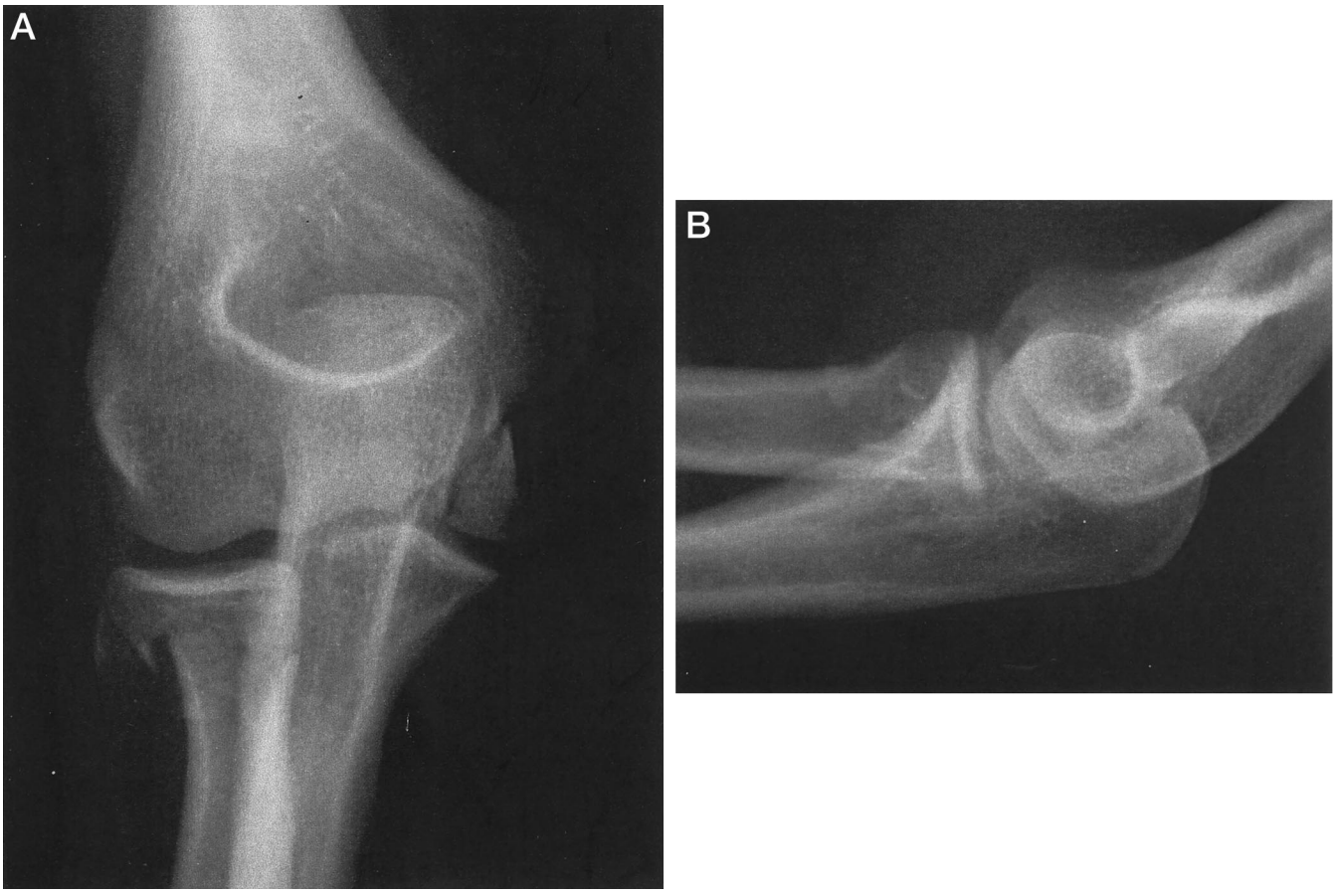

Fig. 1. *Initial anteroposterior (*A*) and lateral (*B*) radiographs of the elbow demonstrating the fractures of the trochlea and the radial neck.*

provisionally fixed with fine Kirschner wires. The definite fixation was accomplished with the insertion of four cannulated 3.5-mm Herbert screws. The fracture of the radial head appeared to be stable during visual and fluoroscopic examination, so it was decided to treat it conservatively, in order to avoid increasing the surgical trauma. The ulnar nerve was exposed proximally and distally and was transposed anteriorly and subcutaneously to avoid postoperative compression from fracture callus and periarticular fibrosis.[17] The olecranon osteotomy was stabilized with a 6.5-mm cancellous screw and a tension band wire. After completion of the skeletal fixation, the elbow was taken through the full range of motion, without any tendency to dislocate. The stability to valgus stress was evaluated during application of valgus stress in 30 and 70 degrees of elbow flexion with the forearm in pronation and increase of the medial joint space was ascertained. The decision to explore the MCL was made to anticipate a possible chronic valgus laxity of the elbow. The flexor-pronator muscle mass was retracted anteriorly, without detaching its origin, the MCL was exposed, and partial detachment from its humeral origin was ascertained. The MCL tear was subsequently repaired using heavy (No. 2), braided, nonabsorbable transosseous sutures. The reduction of the elbow joint was concentric in the anteroposterior and the lateral plane. The arm was immobilized in a long arm thermoplastic splint for 3 weeks to facilitate soft tissue and bone healing. For the following 4 weeks, a hinged brace was used, allowing limited, controlled flexion and extension. The use of the brace was followed by an intensive physiotherapy program. The fracture healed in excellent position (Fig. 3). The patient regained full flexion and extension as well as forearm rotation and was able to return to his previous employment as a farmer. The patient was evaluated every 3 months and was followed up for 30 months. He reported only mild discomfort with weather changes. No laxity to valgus stress was evident. The final result is rated as excellent, according to the criteria of the Elbow Functional Rating Index.[18] The screw and the wire stabilizing the olecranon osteotomy have been removed 1 year after the initial operation.

DISCUSSION

Direct and indirect trauma to the elbow may inflict injury to the bone and articular components as well as to the ligaments, capsule, and muscles. Recognition of individual lesions is vital to comprehend the pathomechanics of the injury and to devise a suitable treatment plan.

The stabilizing structures of the elbow joint can be thought of as components of a ring. Injury of one part of the

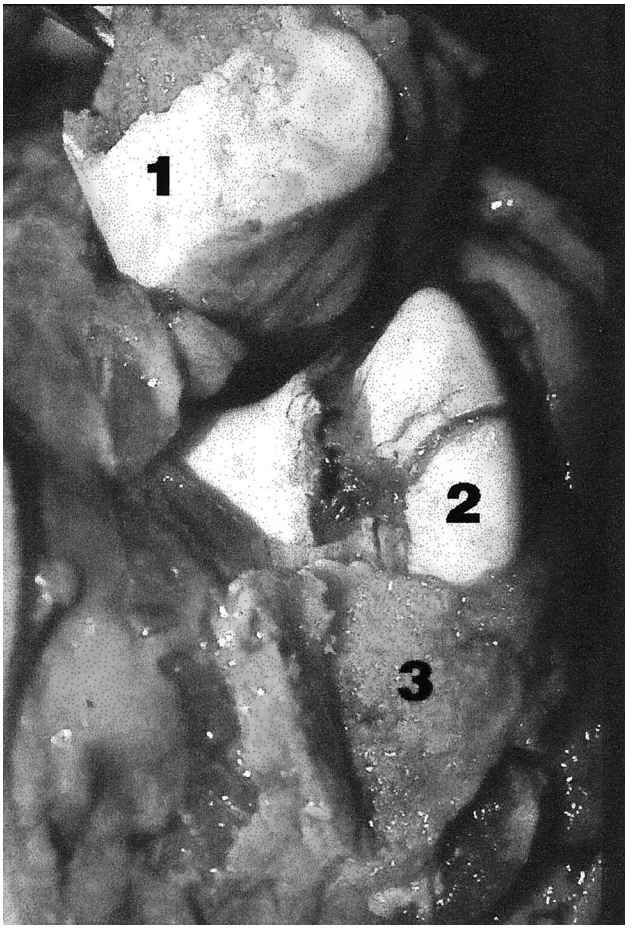

Fig. 2. *Intraoperative photograph exhibiting the T-shaped fracture of the trochlea.* 1, *Osteotomized olecranon;* 2, *trochlea, medial ridge;* 3, *chevron osteotomy of the olecranon.*

ring is followed by injury of another part. The restoration of joint stability necessitates the restoration of every part of the ring. Elbow stability depends on the interaction between static and dynamic stabilizers. Osseous structures, ligaments, and muscles contribute to elbow stability. Osseous structures make a significant contribution to overall joint stability and are reinforced by the medial and lateral ligament complexes as well as by the flexor-pronator and extensor musculotendinous units. The bony and ligamentous anatomy of the ulnohumeral joint allows for 3 to 4 degrees of varus-valgus laxity.[1,16] In 90 degrees of flexion, the MCL provides 54% of valgus elbow stability, the osseous structures provide 33%, and the remaining soft tissues only 10%. In full extension, each structure has almost equal contribution (31%, 31%, and 38% respectively).[19] Transection of the entire anterior band of the MCL increases the medial joint opening by 5.9 mm, which results in impact on the radial head.[20] Isolated injury of the anterior band may occur when the elbow is flexed between 0 and 90 degrees, whereas combined injury of the anterior and posterior bands occurs at greater degrees of flexion, when both bands are co-primary restraints.[21] The radial head has a significant load transmission function. The greatest force transmission occurs between 0 and 30 degrees of flexion, whereas it decreases with further flexion but increases when the forearm is in pronation.[22] A radial head fracture per se does not cause elbow instability, unless there is disruption of the MCL, and its presence influences significantly the prognosis of the injury.[16,23,24]

Elbow instability may be divided according to the direction of displacement into anterior, varus, valgus, and posterolateral rotatory instability, which is the most common pattern of recurrent elbow instability.[16,25] Valgus instability of the elbow is often posttraumatic, implies disruption of the MCL, and is usually seen in patients with radial head fractures and in patients with elbow dislocation, after disruption of the lateral ligament complex. Valgus instability may also occur from repetitive microtrauma or overload in overhead athletes, especially pitchers.[25] Although elbow instability constitutes a spectrum of injuries, simple dislocations and isolated MCL tears have favorable prognosis with conservative treatment.[15,26] Diagnosis of elbow joint instability, with or without the presence of concomitant fractures, is clinical and radiologic and may be made by physical examination, with or without anesthesia, dynamic and static radiography, magnetic resonance imaging, ultrasound, and arthroscopy. The elbow joint must be taken through full range of motion and any tendency to dislocate or subluxate must be taken into consideration. The elbow is flexed 10 and 30 degrees and the shoulder is internally rotated for the valgus test and externally rotated for the varus test to minimize humeral rotation. Posterolateral rotatory instability is diagnosed clinically using four physical examination tests, of which the most important are the lateral pivot shift apprehension test and the lateral pivot shift test or posterolateral rotatory instability test. Dynamic radiography under valgus load reveals increase in the ulnohumeral joint space, and magnetic resonance imaging may reveal loss of normal signal intensity or rupture and avulsion of the MCL.[4]

Preoperative and intraoperative judgment must be made for the need to repair or reconstruct the disrupted elbow ligaments. The elbow stability must also be tested after completion of the fixation of concomitant fractures. If a stable arc of motion (60 degrees of flexion to full flexion) cannot be established after fracture fixation, ligament repair of reconstruction is undertaken followed by the application of a hinged external fixator, when necessary. When there is isolated disruption of the lateral collateral ligament, the elbow is more stable with the forearm pronated, and when there is isolated disruption of the MCL, it is more stable in supination. When both ligaments are disrupted, forearm rotation does not improve elbow stability. In case of inadequate ligamentous healing, instability of the elbow—either subluxation or dislocation—may ensue.[14,16,25,27] In our case, the stability of the elbow was examined after osteosynthesis of the trochlear fracture and fixation of the olecranon osteotomy. Persistent laxity to varus testing was detected and the

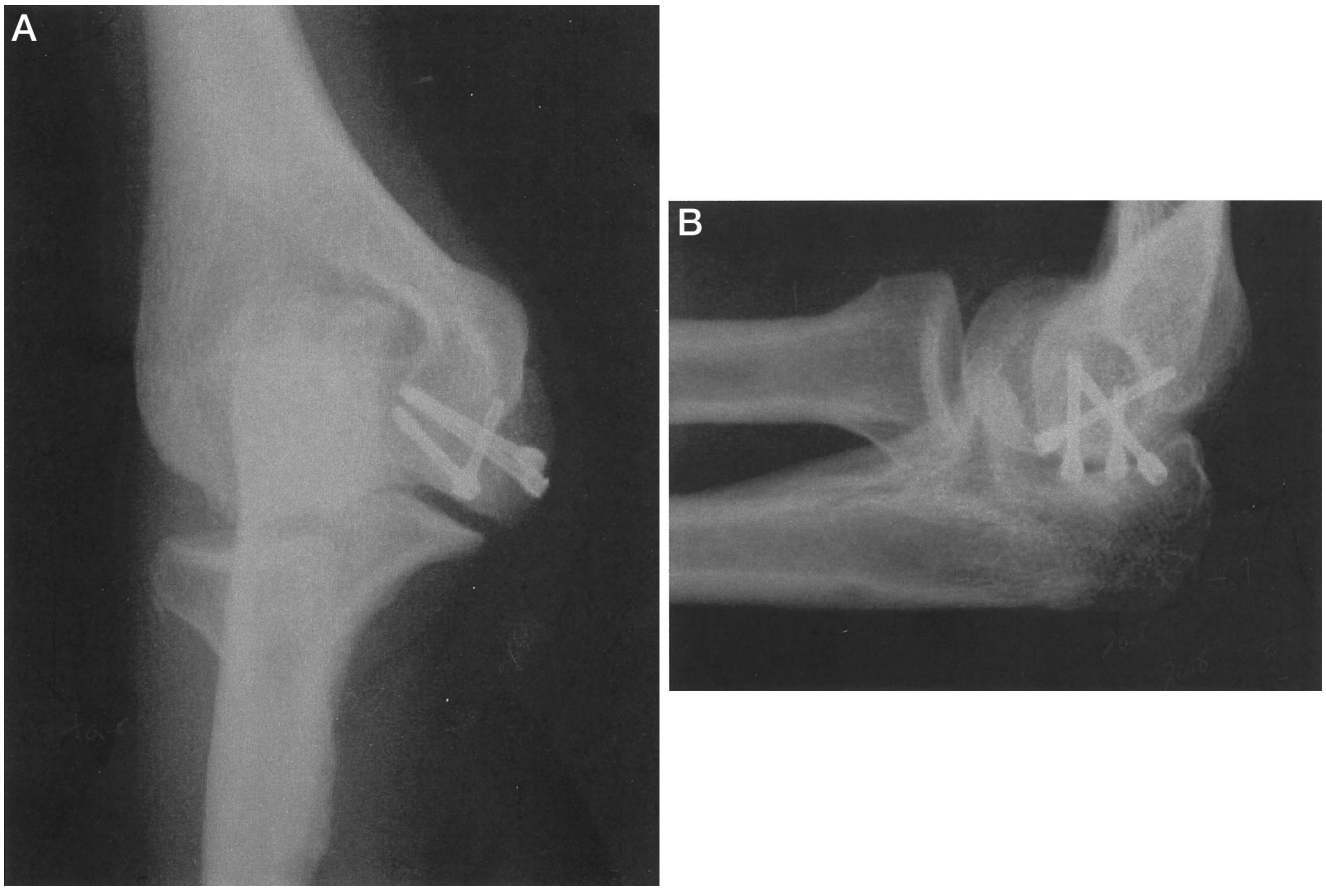

Fig. 3. *Anteroposterior (*A*) and lateral (*B*) radiographs of the elbow 24 months postoperatively. The ulnotrochlear joint space is preserved. The osteosynthesis materials, a 6.5-mm cancellous screw and a wire, have been previously removed.*

decision to explore and repair the MCL was made. Hinged, external elbow fixators may be useful in treating acute elbow instability after fixation of comminuted distal humeral fractures and can also be used in the management of recurrent, complex instability of the elbow. The application of those fixators is demanding and there is no room for errors.[6,28,29]

Fractures of the capitellum and the trochlea represent a surgical rarity and are commonly missed on the first examination. Coexistence of these fractures has also been reported.[8] The occurrence of isolated trochlear fractures, first described by Laugier in 1853, is extremely unusual. This fracture may occur in adults[4,10–12] as well as in adolescents.[5,8] The spool-shaped trochlea is interposed between the medial and the lateral column of the distal end of the humerus, and preservation of its shape is essential for the maintenance of the stability and the preservation of the arc of motion of the elbow joint. Narrowing of the trochlea, after internal fixation of comminuted intra-articular fractures, results in instability and articular incongruity of the ulnohumeral joint predisposing to the development of posttraumatic osteoarthrosis.[2,3] It is possible to diagnose the fracture using plain radiographic imaging. Inability to obtain at least two films of the elbow taken at 90 degrees to one another may lead to underestimation of the injury severity and to failure to make the correct diagnosis. Direct and indirect signs of elbow fractures should be carefully searched for. More sophisticated imaging techniques such as computed tomography and three-dimensional computed tomographic imaging may also be used, aiding the establishment of the diagnosis and the preoperative planning. Usually, the trochlea fractures in the coronal plane, because of the application of shearing forces and, if displaced, translates anterosuperiorly, appearing as a half-moon-shaped osteochondral fragment in front of the anterior surface of the distal end of the humerus, similar to the radiologic appearance of a displaced capitellum fracture.[30,31] In the literature, the fracture has been treated surgically using the medial[4,5,8–12] or the posterior approach to the elbow joint.[8] The trochlear osteochondral fragment can be repositioned with Kirschner wires, bioabsorbable rods, and Herbert screws. The double-threaded design of these headless screws allows them to sink below the level of the articular cartilage, affording the interfragmentary compression necessary for fracture healing without interfering with joint motion. Smaller pieces of articular cartilage may be discarded, and if there is significant loss of subchondral bone, bone grafting should be performed, buttressing the osteosynthesis. In the

literature, the results of the surgical treatment of trochlear fractures are usually good, with preservation of the functional range of elbow motion, even in cases with anterior fracture-dislocation of the elbow. In one report, a slight displaced fracture of the trochlea in a 12-year-old girl, sustained after a fall from a horse, was treated conservatively using olecranon overhead traction for 3 weeks; the posttreatment elbow functional status was not reported.[7] In our case, the fractures may have been induced by a combination of mechanisms. The greater sigmoid notch of the ulna probably struck directly against the articular surface of the trochlea and fractured it. A valgus force that followed caused rupture of the MCL and subcapital fracture of the radial head. The exerted forces ceased without causing dislocation of the elbow, which would be the next step in the cycle of force application.

Fractures of the radial head occur often in dislocations of the elbow.[14,16] The combination of a radial head fracture and a ligamentous disruption increases significantly the severity of the injury and affects unfavorably the healing ability of the injured structures. The preservation and anatomic restoration of a radial head fracture is crucial in maintaining the stabilizing effect of the radiocapitellar contact, allowing the elbow collateral ligaments to heal with proper tension. When preservation of the radial head is not possible, this must be replaced with a metal prosthesis.[32] When the fracture of the radial head extends to the radial neck, osteosynthesis may be accomplished with a small fragment plate; if it is comminuted, the use of an osteoarticular radial head allograft has been suggested because of the lack of sufficiently long prostheses.[24]

Protection of the healing articular fracture must precede the healing of the soft tissues, since instability of the elbow because of bone loss or articular malalignment is much more difficult to treat than stiffness. Release of the elbow capsule at a later time is an efficient method for restoration of elbow motion. Although acute injuries are easier to diagnose, chronic injuries are much more difficult to diagnose, classify, and treat. It is preferable to treat properly an acutely dislocated and/or unstable elbow than to reconstruct a chronically unstable one.[16] When attempting to reconstruct an acutely or chronically unstable elbow, not only ligament disruptions but also deficiencies of the coronoid, olecranon, and/or radial head must be addressed. The reconstruction of bone deficiencies is as important as ligament reconstitution. The temporary use of a hinged external fixator is important for protecting bones and ligaments during the healing period.[27]

In summary, although rare, fracture of the trochlea may be encountered, isolated or in combination with elbow dislocation, leading to significant elbow joint morbidity. If displaced, this fracture has to be internally fixed, addressing at the same time all other associated soft tissue and bone injuries, which may be of equal importance. Open reduction and internal fixation may provide good results.

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G. WHITAKER INTERNATIONAL BURNS PRIZE FOR 2002

Palermo, Italy—The 2002 G. Whitaker International Burns has been awarded to Prof. René Artigas Nambrard (Chile), former Chief of Burns Center and Plastic Surgery of the Petequial Gonzales Cortés Hospital of Santiago.

The prize is awarded with the following motivation:

Prof. René Artigas Nambrard, working in the difficult times and conditions of his country, perceptively identified the burns pathology as a real social problem that needed to be aproached from a particular angle. His commitment to this work, starting from an analysis of the various aspects involved—epidermiological, especially in children, socioeconomic, organizational, and that of general care—has brought him to support the principle that burn patients require appropriate treatment and assistance in an environment that is totally suited to their needs. On the basis of this conviction, he began his activity at M. Arriaran Hospital of Santiago in 1960, setting up a section of five beds for burn care, which in 1964 became a department with 16 beds and later, in 1967, the first burns center in Chile, with 30 beds. In 1975, he founded the second burns center in his country at E. G. Cortés Hospital where he was chief until June 1985. He has passed on the result of his studies and the experience he has acquired at qualified burns centers in numerous countries through ceaseless activity in the training of young physicians, in Chile and elsewhere, and in his creation of a Chilean school of burns. His intense activity in the field of prevention has won him numerous attestations of merit from the authorities in his country. He founded the Chilean Burns Society of which he was the first president. With his work recognized beyond the confines of his country, he contributed to the constitution of the Federation of Latin American Burns Societies and was appointed President of the Ibero Latin American Committee for burns prevention and treatment. Numerous international awards testify to his commitment in the entire South American continent in every sector of burns pathology and the organization of burn care. The results of his activities have been published in eight volumes that today are a point of reference for young physicians. These aspects of the professional activities of Dr. René Artigas Nambrard also reveal the human side of a physician who has devoted his efforts to the dramatic problems of burns.

Nominations for the 2003 award are now being accepted. Anyone who considers himself to be qualified to compete for the award may send their detailed curriculum vitae by **January 31, 2003** to: Michele Masellis, MD, Secretary-Member of the Scientific Committee, G. Whitaker Foundation, Via Dante 167, 90141, Palermo, Italy. The amount of the prize is fixed at 10,329 Euro. The prize will be awarded in the month of June in Palermo at the seat of the G. Whitaker Foundation.