

Epidemiology of Waterskiing Injuries

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Coast Guard statistics indicate a national boating fatality rate of 9.6 deaths per 100,000 crafts. In 1977 in California, five fatalities and 70 serious injuries were directly attributable to waterskiing. The four cases reported here include three patients with propeller injuries, including one nearly fatal amputation. In each case basic measures for boating safety were overlooked.

SKIERS IN MINNESOTA in 1922¹ and in Washington state in 1928² have been credited with first adapting their snow skis to waterskiing. The popularity of waterskiing has risen dramatically in the past decade, influenced in part by a general reduction in the length of the average work week, coupled with a notable rise in the number of propeller-driven small craft. According to the latest edition of *Coast Guard Boating Statistics*,³ the overall fatality rate for boating injuries per 100,000 persons declined from 20.8 in 1961 to 9.6 in 1977. However, the estimated number of boats afloat rose from 5.85 million to 13.6 million in the same time. Fatalities attributable to waterskiing in the United States in 1977 totaled 43. During the same year five fatalities and 70 serious injuries directly involving water-skiers were registered in California (personal communications, Mr. Harvey H. Houk, Supervisor of the Enforcement Unit, State of California Department of Navigation and Ocean Development). The following four cases of serious waterskiing injuries treated in a community hospital near San Diego Bay during the past four years illustrate the potentially seri-

ous hazards associated with this recreational activity.

Reports of Cases

CASE 1. Two girls were swimming in San Diego Bay when one girl attempted to dive beneath an oncoming boat that was towing a water-skier. The trunk of the patient was submerged; however, both buttocks received serial lacerations of the skin and subcutaneous tissues from the propeller. After initial evaluation in the emergency room, surgical repair was done under general anesthesia. The lacerations penetrated to, but did not involve, the gluteal musculature. Debridement, closure over drains, and prophylactic antibiotic administration for 96 hours resulted in primary healing of wounds with no sequelae.

CASE 2. The second of the two girls was struck by the same propeller and received massive lacerations involving both buttocks, and presacral and right thigh regions (Figure 1). Fluids were given intravenously, and blood was typed and crossmatched for replacement. On physical examination an open transverse subtrochanteric fracture of the right femur, anesthesia and motor loss distal to the knee were noted (Figure 2). The right gluteal wound penetrated to the ischial tuberosity with exposure and partial laceration of

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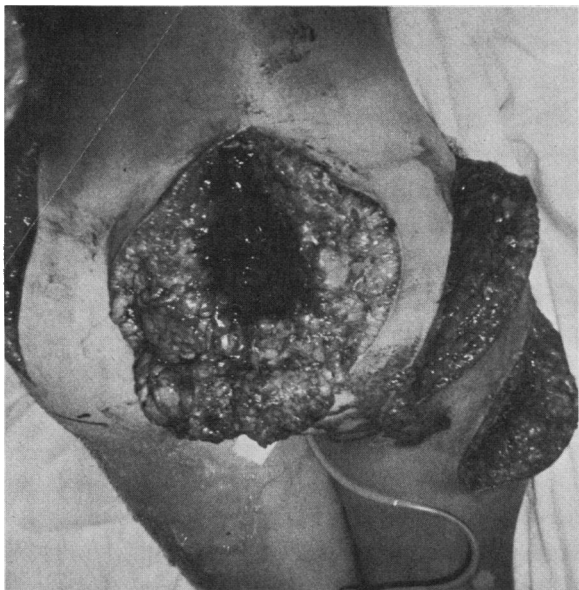


Figure 1.—(Case 2) Massive serial gluteal and thigh lacerations from a propeller. The patient is an 8-year-old-girl who attempted to dive beneath an oncoming boat that was towing a water-skier.

the sciatic nerve. The bladder was catheterized, resulting in prompt return of clear urine.

During surgical operation all wounds were debrided with copious irrigations supplemented with bactracin and kanamycin sulfate (Kantrex) solution. The sciatic nerve laceration involved the posterior 20 percent of the nerve immediately adjacent to the superior aspect of the ischial tuberosity. Epineural repair was carried out and all wounds were loosely approximated over large Penrose drains. The patient was turned to a supine position and the femoral fracture was treated in skeletal traction in a 90-90 overhead position. A similar means of traction for the uninvolved left leg allowed suspension of the lower trunk and buttocks for appropriate wound and perineal care. After four weeks all wounds had healed except for one area of the right buttock that required split-thickness skin grafting.

In the sixth week the patient was placed in a double spica cast and was discharged eight weeks following the injury. In the 12th week the patient's spica cast was removed, and trace function of the gastrosoleus, flexor hallucis and flexor digitorum comminis muscles was noted. The patient was allowed to use crutches with a polypropylene orthosis for the ankle and foot; she resumed walking without crutches six months after injury. Nine months after the injury, results of electromyographic examination showed elec-

trical activity in the gastrocnemius and anterior tibial and peroneal muscles. After ten months anterior tibial and peroneal muscle function was clinically detectable. Complete protective sensation and proprioceptor response returned after 14 months and, following 16 weeks of serial short leg-stretching casts, a heel cord contracture of 10 degrees was overcome. The patient was then discharged from care 24 months after injury. She could walk without assistance, and there was normal motor and sensory function of the right leg.

CASE 3. A 56-year-old woman, a water-ski instructor with 25 years of experience, was demonstrating a "from the beach start" for a class of beginning water-skiers when her left leg became entangled in the tow rope. Her husband, who was piloting the boat, immediately cut the throttle. Nonetheless, the woman was pulled forward with her foot locked into the ski; this caused a pronation external rotation grade 3 dislocation fracture of the ankle (Figure 3). The woman's wet suit protected her skin, which had only partial thick-



Figure 2.—(Case 2) Anteroposterior roentgenogram made on the patient's admission to hospital. Open subtrochanteric fracture of the right femur is shown. A 20 percent transection of the sciatic nerve occurred at the level of the ischial tuberosity.

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ness abrasions of the epithelium. Surgical repair of the deltoid ligament with internal fixation of the fibular malleolus was immediately begun

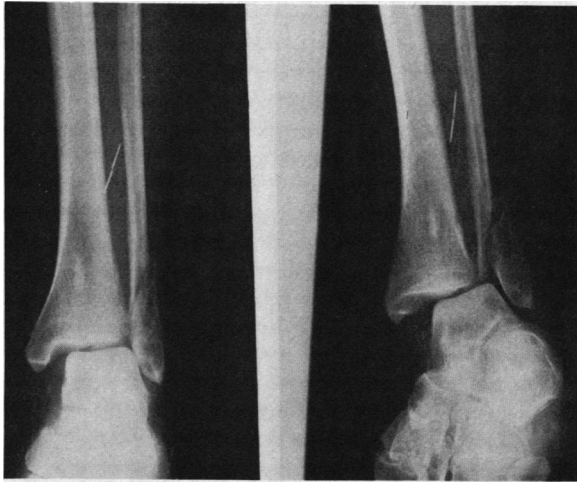


Figure 3.—(Case 3) Initial x-ray film of a pronation external rotation grade 3 dislocation fracture of the ankle that occurred when a water-ski instructor was caught in a tow rope while demonstrating a take-off from the beach.

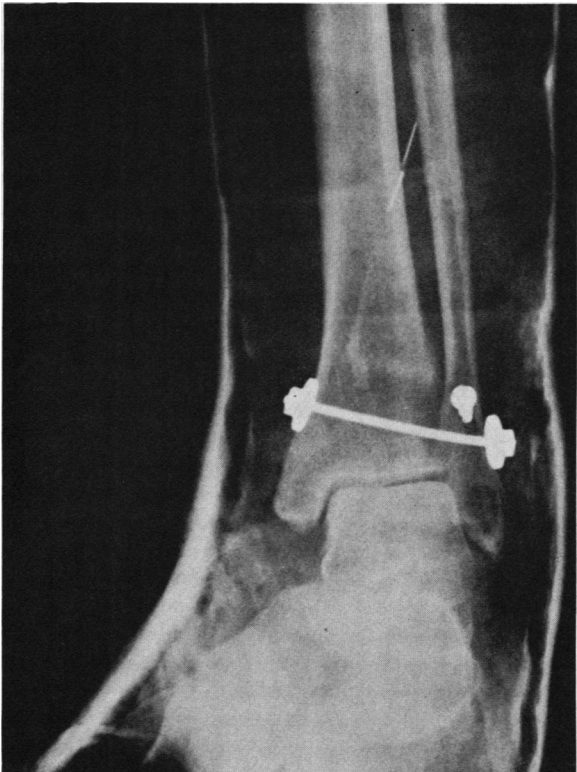


Figure 4.—(Case 3) Roentgenogram made following surgical repair of the deltoid ligament and fixation of the fibular fracture. A sewing needle shown in the anterior soft tissue of the distal pretibial area is not related to the waterskiing injury.

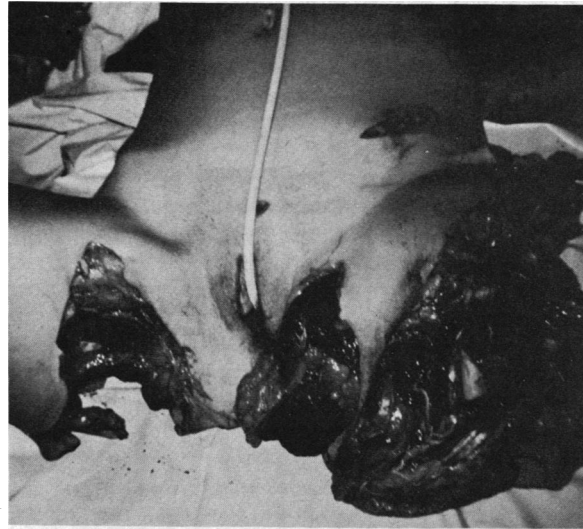


Figure 5.—(Case 4) A 31-year-old woman, preparing to water ski, was struck by a boat. There was complete amputation of the left leg and transection of the soft tissues of the posterior aspect of the right thigh excluding the femur, femoral vessels and sciatic nerve.

(Figure 4). The patient's convalescence was uneventful and she returned to recreational skiing nine months after the injury.

CASE 4. A 31-year-old woman, preparing to water ski, was submerged at the stern of a boat when it was suddenly reversed and backed down upon her. The left leg and thigh were amputated, and severe propeller lacerations of the right thigh occurred before the woman could be pulled into the boat. Pressure pack dressings were applied to the pelvic area and the patient was transported by a police ambulance to the emergency room. The patient was conscious with no obtainable blood pressure. Following resuscitation measures and fluid replacement, physical examination showed complete avulsion of the left sacroiliac joint with the ilium lying free on a pedicle flap of the iliac muscle. The left femoral artery was stretched from its surrounding muscle and was in spasm with no active bleeding. The posterior aspect of the right thigh had a deep propeller laceration extending from the pectineal muscles posteriorly with transection of the medial hamstring and adductor musculature, and with no injury of the femur, iliac vessels and sciatic nerve (Figure 5).

A hip disarticulation was carried out in the left pelvic region and the iliac bone was secured with Steinmann pins. After extensive soft tissue debridement, the posterior gluteal flap was loosely closed over a large number of Penrose drains. The right thigh wound, after debridement, was simi-

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larly closed loosely after repair of the adductor and hamstring musculature (Figure 6).

The patient's convalescence was prolonged and complicated by the development of a mixed aerobic and anaerobic necrotizing synergistic infection with cultures of Gram-positive cocci, clostridia, bacteroides and aerobic Gram-negative bacilli. Antibiotic therapy included cephalothin sodium (Keflin), penicillin, clindamycin and gentamycin. The patient was returned to surgery five days after injury so that intermittent suction irri-

gation systems could be used, and further debridement of necrotic tissue could be carried out. Further necrotic tissue was debrided 11 days after injury. Profuse arterial bleeding from the depths of the wound adjacent to the acetabulum was controlled by vaginal packs and during the next eight weeks all major wounds healed except a chronic sinus tract adjacent to the acetabulum (Figure 7). The patient regained full use of the right leg and was discharged on crutches three months after injury.

She returned to the hospital four months after the injury for resection of an avascular segment of the ilium; the wound healed completely (Figure 8). She was fitted with a Canadian type hip



Figure 6.—(Case 4) Posterior view of propeller lacerations following hip disarticulation and wound closure.

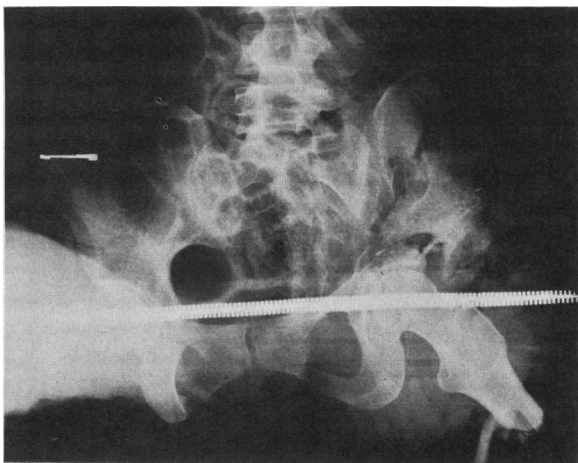


Figure 7.—(Case 4) Anteroposterior view of the pelvis on the patient's admission to hospital showing bilateral pubic fractures and complete disruption of the left acetabulum and ilium, in addition to subtrochanteric amputation of the left femur.

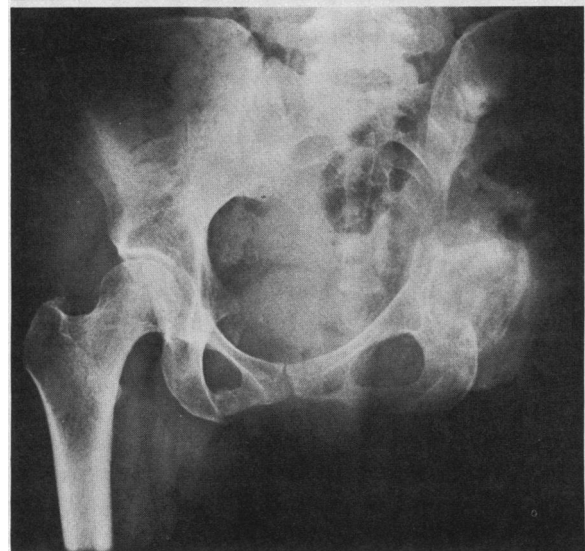
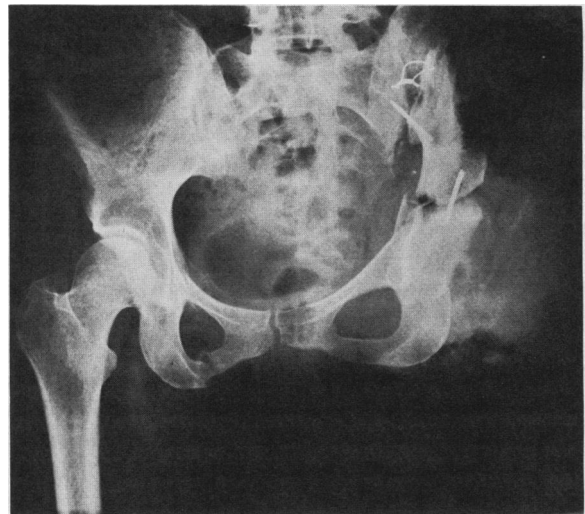


Figure 8.—(Case 4) Shown are anteroposterior views of the pelvis one and two months following injury (**upper**), initial fixation of the pelvis and (**lower**), subsequent excision of avascular iliac fragment.

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disarticulation prosthesis six months after injury and returned to work as an accountant nine months after injury.

Discussion

Stanisauljevic recently reviewed the causes of orthopedic injuries similar to those in case 3 in this series and identified several related factors including the inexperience of water-skiers and pilots, and excessive boat speed. He estimated that more than 2 million people water-ski in the United States. McCarthy⁴ reported a case in which a young woman fell while skiing and received a 5-cm laceration in the fornix vaginae. Ramey⁵ reported the case of a young woman who fell while skiing, which resulted in an intrarectal tear with profuse hemorrhage. Both of these cases involved women wearing brief swimming suits and the authors speculate that the use of more protective apparel, such as wet suits, might have precluded severe injuries.

Three of the four cases were directly attributable to deficient boat handling. The third case would have involved open fracture or possible amputation were it not for the prompt attention of the driver.

The most devastating injuries, however, are caused by propellers, as is well-documented by Mann.⁶ In his series of nine cases from Miami there were three deaths and three amputations. Propeller injuries usually result in a series of transverse incisions as each blade sequentially strikes further up the victim's body as illustrated by the photographs. In addition to the frequent massive soft tissue and bone injuries, there is the threat of severe wound infections from bacterial contamination. Case 4 illustrates the catastrophic nature of propeller injuries and the problems of subsequent infection in spite of radical debridement, extensive drainage and broad spectrum antibiotic therapy. These propeller injuries are the civilian equivalent of severe battlefield injuries.

Analysis of the 1977 California waterskiing injury statistics⁴ shows that of five skiers who were killed, two skiers struck rocks, two were struck by the boat, and one lost the ski belt and sub-

TABLE 1.—Causes of Waterskiing Injuries in California in 1977

Fall	17
Tow line	13
Boat	10
Ski	7
Propeller	7
Beach	6
Rocks	5
Trees, logs	2
Buoy	2
Bridge	1
	70

sequently drowned. The 70 injuries reported could be classified according to causes shown in Table 1.

As shown by a review of the United States *Coast Guard Boating Statistics*, waterskiing fatalities rose from 34 in 1976 to 43 in 1977. There is evidence that an increase in population with overcrowding of available water space in the San Diego Bay area, resulting in inadequate separation of boating and bathing areas, was a significant factor in two of the four cases reported here.

Conclusions

With the increasing popularity of waterskiing, records of injuries are showing increases in total incidence and fatalities. Education of both skiers and drivers could reduce substantially the incidence of serious injury. Accidents involving propellers remain the chief cause of devastating and mutilating injuries. Medical treatment of these catastrophic injuries should be comparable to the treatment of massive battle wounds, with adequate debridement and secondary closure techniques in addition to appropriate antibiotic therapy.

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