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# Pediatric golf-related head injuries

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**Abstract** *Objectives:* Golf-related head injuries constitute an increasingly common mechanism of head trauma in children. We present our experience with 33 pediatric cases of golf-associated head injury, with special emphasis in the type of injury, management strategy, and outcome. *Materials and methods:* A thorough review of all children admitted to our hospital with golf-related head injury during a period of 10 years (1 January 1994 to 31 December 2003) was undertaken. The patients' charts, operative reports, imaging studies, and follow-up data were analyzed. A comparison of our findings with those described in the pertinent literature was subsequently performed. *Conclusions:* Pediatric golf-related head trauma is a significant cause of sport-associated head injury, sometimes harboring a very dismal prognosis. The significance of establishing a task force for the prevention of these injuries cannot be overemphasized.

**Keywords** Depressed · Elevation · Golf · Head injury · Outcome · Skull fracture

## Introduction

Sport-related injuries represent a relatively common reason for admission to the emergency room [1, 3, 6, 12, 13]. Although the vast majority of these injuries concern the musculoskeletal system, the most serious ones definitely regard head injuries [3, 6]. In a landmark paper by Lindsay et al., among the sports responsible for head injuries, golf, and not a contact sport, had the leading role [6]. Since then, several articles have been reported on the association of golf with head injuries, indicating the potential danger of this recreational activity [2, 4, 6–17]. Additionally, the increasing popularity of this sport due to the extensive and frequent airing of tournaments on TV and the booming of the Tiger Woods' social phenomenon has introduced golf to a wider and also younger audience, which has resulted in an increasing number of golf-related head injuries, particularly among young children and adolescents. This pattern is clearer in certain geographical areas where golf is very popular.

In our current communication, we present our experience in the management of pediatric patients sustaining head injuries due to golf-associated accidents, and we attempt to emphasize the fact that occasionally these injuries can be severe and have disastrous outcome.

## Materials and methods

In a retrospective study, performed at our institution, 33 pediatric patients (<17 years old) admitted to our service over a period of 10 years (1 January 1994 to 31 December 2003) with the diagnosis of a golf-related head injury were included. This group of patients represented the most commonly occurred sport-related head injury in our service (Table 1). Sport-related head injuries constitute 8.5%

**Table 1** Pediatric sport-related head injuries admitted to our institution during our study period

| Golf-related head injury | 33 patients |
|---|---|
| American-football-related head injury | 30 patients |
| Bicycling-related head injury | 23 patients |
| Soccer-related head injury | 12 patients |
| Basketball-related head injury | 7 patients |
| Baseball-related head injury | 6 patients |
| Softball-related head injury | 4 patients |
| Gymnastics-related head injury | 4 patients |
| Trampoline-related head injury | 4 patients |
| Water-skiing-related head injury | 3 patients |

(126/1,481) of all pediatric head injuries. The hospital and outpatient clinic charts of these patients, their operative reports, and their radiographic studies were thoroughly reviewed. The study was performed under our Institutional Review Board (IRB) approval and the Health Insurance Portability and Accountability Act (HIPAA) regulations were strictly followed.

All the patients included in our study were admitted to our facility either directly (13 cases) or transferred from a referring hospital (20 cases). Thirty-three patients, 14 females and 19 males with mean age of 7.5 years (range 3–16), underwent radiographic work-up including head CT scans without contrast with three-dimensional reconstruction while occasionally plain skull X-rays and brain MRI studies were obtained.

## Results

The vast majority of our patients suffered a depressed skull fracture (28/33, 84.8%), while 4/33 (12.1%) had an epidural (Figs. 1a,b, and 2) and one patient (3.1%) a subdural hematoma. Five patients in our series (15.1%) had cerebral contusions, and two of them (6.0%) an evidence of diffuse traumatic SAH. As regards the mechanism of injury, 23 patients (69.6%) suffered a golf-club head injury (Figs. 3, 4a,b), eight (24.2%) had a golf-ball injury (Figs. 5, and 6a,b), while in the remaining two patients (6.0%) their head injury was the result of a golf-cart accident.

Interestingly, the location of the accident was a golf course in only 14 cases (42.4%), while in the rest of our cases, the accident occurred elsewhere. In all golf-ball injuries, an adult was responsible for the accident while in 9/23 (39.1%) cases of golf-club injury, a child was responsible. Surprisingly, in one of the golf-cart related injuries, an 8-year-old child was driving a golf cart, unattended.

Regarding the anatomical location of the sustained pathology, a strong predilection for frontal and temporal areas was evident (Table 2). Surgical treatment was employed in 25/33 (75.7%) patients consisting most commonly of elevation of depressed skull fractures and, rarely, evacuation of epidural and subdural hematomas (Table 2). Elevation of the depressed skull fracture, repair of the underlying violated dura, whenever necessary, and reconstruction with the use of craniofacial titanium miniplates were routinely performed. In cases of young children

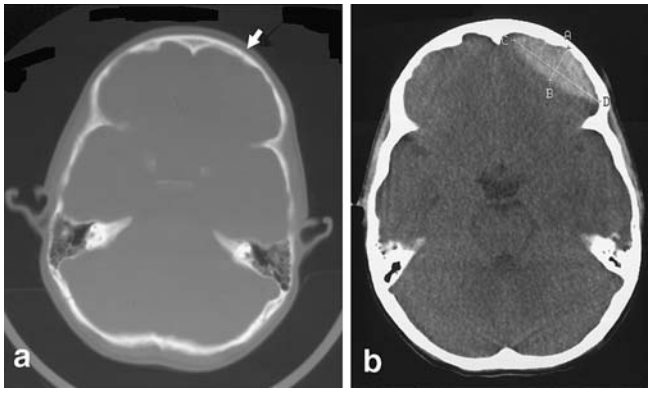


**Fig. 1** **a** Pre-operative head CT scan (bone window) demonstrating a linear left frontal fracture secondary to a golf ball impact; **b** pre-operative head CT scan (parenchymal window) on the same patient demonstrating a left frontal epidural hematoma

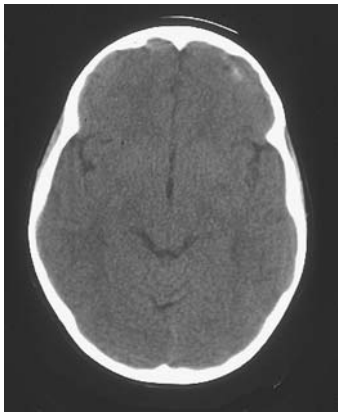

**Fig. 2** Post-operative head CT scan (parenchymal window) demonstrating evacuation of the left frontal epidural hematoma

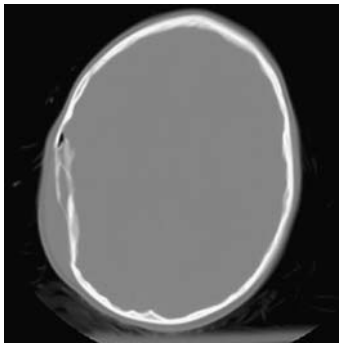

**Fig. 3** Pre-operative head CT scan (bone window) demonstrating a depressed skull fracture secondary to a golf club impact

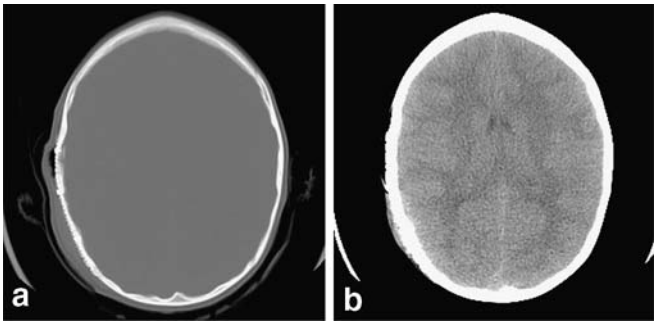


**Fig. 4** **a** Post-operative head CT scan (bone window) demonstrating the reconstructed skull after surgical elevation on the same patient; **b** post-operative head CT scan (parenchymal window) demonstrating the reconstructed skull after surgical elevation on the same patient

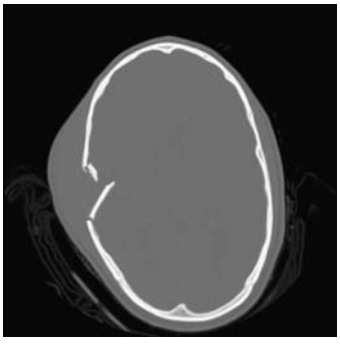

**Fig. 5** Pre-operative head CT scan (bone window) demonstrating a depressed skull fracture secondary to a golf ball impact

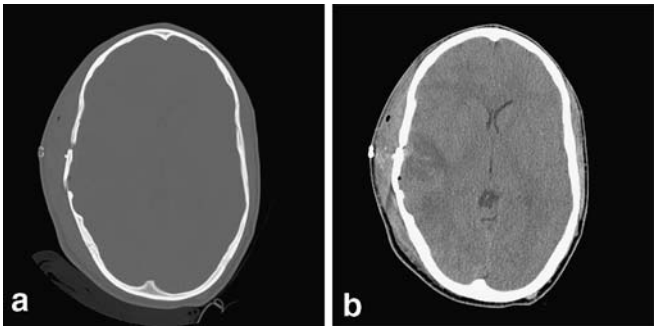


**Fig. 6** **a** Post-operative head CT scan (bone window) demonstrating the reconstructed skull after surgical elevation on the same patient; **b** post-operative head CT scan (parenchymal window) demonstrating the reconstructed skull after surgical elevation on the same patient

with growing skulls, resorbable craniofacial mini-plates, screws, and mesh were utilized (Figs. 7a,b, 8a,b). An attempt to use the patient's own bone for reconstruction was made in all cases of surgical elevation of depressed skull fractures. Eight patients (24.2%) were conservatively managed, while in three of them intracranial temperature and pressure, cerebral perfusion pressure, tissue oxygen, and pH were invasively monitored.

All patients in our study were followed for a minimum of 12 months and their outcome was assessed by the GOS score at 1, 6, and 12 months after their injury. The mean GOS score at 1 month was 4.74 (range 3–5), at 6 months 4.75 (range 3–5), and at 12 months 4.78 (range 3–5).

## Discussion

The frequency of golf-related head injuries has been adequately outlined in the recent medical literature [2, 4, 6–18]. Since the publication of the landmark paper by Lindsay et al. [6], several clinical series, editorial articles, and case reports have emphasized the fact that golf-related head injuries are the most common sport-related head injuries among children, at least in certain geographical areas such as Scotland in Europe; Florida, Georgia, and Arizona in the USA; Australia; and Southeast Asia [2, 6–18]. The increasing popularity of golf, which is partially a result of mass media promotion along with the emergence of young golf players such as Tiger Woods and Jorge Garcia, has also made golf more appealing to children. Unfortunately, its increased popularity has resulted in an increased incidence of head injuries [5, 19].

The epidemiologic analysis of the reported clinical series leads to some interesting observations. The mean age of the involved children in most of the reported series was approximately 8 years, a finding that is in agreement with our current series [6–8, 12, 16]. Although the acronym of the sport according to a wide spread tale (Gentlemen Only Ladies Forbidden) could imply only male involvement, our data showed that the male-to-female ratio was 1.2:1; a finding that is in agreement with the findings of Rahimi et al. [13], who, in their recent study, reported a ratio of 1.8:1. Contrariwise, Smith et al. [16], in their series, reported 11 golf-associated injuries all in males, and Macgregor [7] reported a male/female ratio of 4:1. This difference might be coincidental or might well represent a new tendency observed in more recent articles reflecting the fact that an increasing number of younger females are attracted by this sport.

Regarding the exact mechanism of golf-related head injuries, club accidents account for the vast majority of cases. In our series, 69.6% of the observed injuries were caused by golf clubs. Similarly, Macgregor [7] reported that 92% of his patients' injuries were attributable to clubs; Smith et al. [16], in their series, reported 81.8%, and Pennycook et al. [12] reported 33 cases of club-related pediatric head injuries. Likewise, Lindsay et al. [6] reported in their series that 92.8% of their injuries were caused by golf clubs. Ridenour in her thorough review article emphasized the frequency of club injuries by calling golf clubs "hidden home hazards for children" [14]. We also observed in our series that 24.2% of our patients sustained a golf-ball head injury, while only 6.2% had a golf-cart injury. Contrariwise, Rahimi et al. reported in

**Table 2** Demographic data, mechanism of injury, management strategy and outcome of patients included in our study

| Patient | Age | Gender | Mechanism of injury | Pathology | Admitting GCS | Anatomic location | Procedure | GOS-1M | GOS-6M | GOS-12M |
|---|---|---|---|---|---|---|---|---|---|---|
| R.N. | 3 | F | Ball | Contusion | 12 | L. frontal | Conservative | 5 | 5 | 5 |
| P.M. | 6 | F | Club | Depressed skull fracture | 15 | L. frontal | Conservative | 5 | 5 | 5 |
| D.L. | 14 | F | Club | Depressed skull fracture | 14 | R. fronto/ temporal | Elevation | 5 | 5 | 5 |
| J.K. | 5 | M | Club | Depressed skull fracture | 13 | R. temporal | Elevation | 5 | 5 | 5 |
| T.A. | 8 | M | Club | Depressed skull fracture | 15 | L. parietal | Elevation | 5 | 5 | 5 |
| C.R. | 16 | M | Club | Skull fracture /subdural hematoma | 8 | L. fronto/ temporal | Elevation/ evacuation | 3 | 3 | 3 |
| V.B. | 4 | M | Ball | Depressed skull fracture | 14 | R. temporal | Conservative | 5 | 5 | 5 |
| J.H. | 7 | M | Ball | Depressed skull fracture | 13 | L. frontal | Elevation | 5 | 5 | 5 |
| L.L. | 12 | M | Club | Depressed skull fracture | 13 | R. frontal | Elevation | 5 | 5 | 5 |
| A.R. | 9 | F | Club | Depressed Skull Fracture | 13 | L. fronto/ temporal | Elevation | 5 | 5 | 5 |
| G.E. | 11 | M | Club | Depressed skull fracture | 14 | L. parieto/ temporal | Elevation | 5 | 5 | 5 |
| D.C. | 9 | F | Ball | Skull fracture/epidural hematoma | 12 | R. temporal | Elevation/ evacuation | 5 | 5 | 5 |
| J.S. | 4 | M | Club | Depressed skull fracture | 14 | L. frontal | Elevation | 5 | 5 | 5 |
| J.F. | 6 | M | Club | Depressed skull fracture | 13 | L. fronto/ temporal | Elevation | 5 | 5 | 5 |
| T.G. | 13 | M | Ball | Depressed skull fracture | 13 | R. frontal | Elevation | 5 | 5 | 5 |
| C.M. | 4 | F | Club | Skull fracture/epidural hematoma | 11 | R. temporal | Elevation/ evacuation | 4 | 4 | 5 |
| J.W. | 12 | M | Club | Depressed skull fracture | 14 | L. frontal | Elevation | 5 | 5 | 5 |
| B.H. | 7 | M | Club | Depressed skull fracture | 13 | R. temporal | Elevation | 5 | 5 | 5 |
| L.E. | 9 | F | Club | Skull fracture/contusion | 8 | L. frontal | Elevation | 3 | 3 | 3 |
| N.H. | 8 | M | Cart | Contusion | 10 | R. Parietal | Conservative | 5 | 5 | 5 |
| L.S. | 12 | M | Ball | Depressed skull fracture | 15 | L. parietal | Conservative | 5 | 5 | 5 |
| D.J. | 4 | F | Club | Skull fracture/epidural hematoma | 9 | R. temporal | Elevation/ evacuation | 4 | 5 | 5 |
| J.W. | 3 | M | Club | Depressed skull fracture | 14 | L. temporal | Elevation | 5 | 5 | 5 |
| R.A. | 5 | F | Club | Skull fracture/epidural hematoma | 8 | L. temporal | Elevation/ evacuation | 3 | 3 | 3 |
| M.C. | 4 | M | Cart | Contusion | 11 | R. frontal | Conservative | 5 | 5 | 5 |
| T.J. | 11 | F | Club | Depressed skull fracture | 13 | L. temporal | Elevation | 5 | 5 | 5 |
| B.A. | 4 | F | Club | Depressed skull fracture | 14 | L. fronto/ temporal | Elevation | 5 | 5 | 5 |
| A.G. | 10 | F | Ball | Contusion | 9 | L. frontal | Conservative | 4 | 4 | 4 |
| E.R. | 9 | M | Club | Depressed skull fracture | 14 | R. frontal | Elevation | 5 | 5 | 5 |
| E.C. | 6 | M | Club | Depressed skull fracture | 15 | R. temporo/ parietal | Conservative | 5 | 5 | 5 |
| J.S. | 4 | M | Ball | Depressed skull fracture | 14 | R. frontal | Elevation | 5 | 5 | 5 |
| Q.J. | 5 | F | Club | Depressed skull fracture | 13 | L. frontal | Elevation | 5 | 5 | 5 |
| J.N. | 3 | F | Club | Depressed skull fracture | 15 | Temporal | Elevation | 5 | 5 | 5 |

their article that 46.6% of their patients had a golf-cart injury [13]. Interestingly, in their report, their only fatality was associated with a golf-cart injury [13]. Tung et al. [17], in their article reporting only adult cases, emphasized the severity of these golf-cart injuries and wisely suggested the enforcement of strict safety regulations during golf-cart driving and absolute ban of driving by adolescents or even children.

Although the frequency of golf-associated head injuries has been adequately addressed in the literature, this does

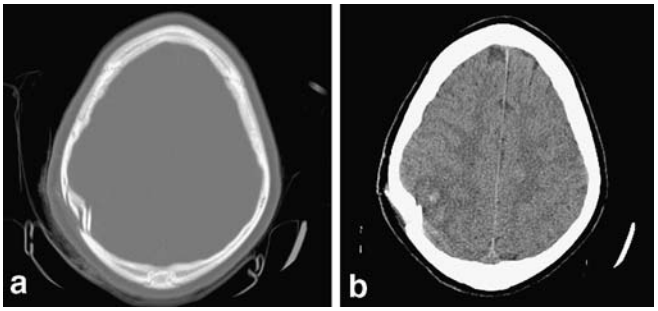


**Fig. 7** **a** Pre-operative head CT scan (bone window) demonstrating a depressed skull fracture secondary to a golf club impact; **b** pre-operative head CT scan (parenchymal window) demonstrating a depressed skull fracture secondary to a golf club impact

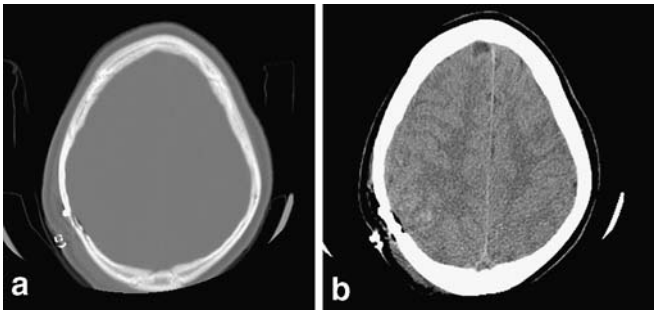


**Fig. 8** **a** Post-operative head CT scan (bone window) demonstrating the reconstructed skull after surgical elevation on the same patient; **b** post-operative head CT scan (parenchymal window) demonstrating the reconstructed skull after surgical elevation on the same patient

not seem to be the case with the severity of these injuries. Lindsay et al. reported that good outcome occurred in all their patients [6]. Similarly, Pennycook et al., in their prospective study, observed full and non-complicated recovery [12]. Macgregor, in his series, also reported excellent outcome [7]. Likewise, Smith et al. reported full recovery of all their patients [16]. On the other hand, in our series, 9.9% of our patients had permanent severe disability. Rahimi et al., reported one death due to uncontrollable brain swelling, while two other patients had chronic headaches and one of them complicated post-traumatic hydrocephalus for which he underwent a shunt placement and multiple revisions [13]. Ridenour reported 19 deaths among 2,033 pediatric golf-related head injuries [14]. Furthermore, Tung et al., in their report, although including only adult patients, reported one with mild cognitive impairment and another who became vegetative and required nursing home placement [17]. Watanabe-Suzuki et al., in an interesting case report, described a death after a golf injury on the neck, secondary to traumatic basal subarachnoid hemorrhage [18]. These data further support our concern that the severity of golf-related head injuries has been underestimated and prognosis might be significantly more dismal than initially considered.

The constantly increasing incidence of golf-related head injuries requires the development of a strategy which will drastically minimize those injuries. The role of prevention cannot be overemphasized in these cases; the addition that was made to the first paragraph in the Rule of Golf handbook published by the US Golf Association and The Royal and Ancient Golf Club of St. Andrews state, represented a good first step towards the right direction [11, 13]. Similarly, the establishment of strict rules regarding the operation of golf carts and the designing of plastic, flexible toy golf clubs for children are measures that could represent some other steps toward a safer practice of golf [14, 17]. However, these measures need to be followed by an extensive outreach program demonstrating the risks associated with this sport and a massive informational campaign targeting parents and young children (6–10 years) emphasizing the risk of potentially lethal head injuries associated with careless practice of golf. The various neurosurgical foundations and organizations should exert pressure to the media and the national golf associations for creating a task force to minimize the golf associated head injuries.

## Conclusion

Our retrospective study outlines not only the increasing frequency but also the severity of golf-related head injuries in children. Depressed skull fracture was the most common pathology observed in our series, while surgical elevation was required in the vast majority of our patients. Although excellent outcome occurred in 87.8% of our patients, unfortunately 9.9% of them remained severely disabled at 1 year after their injuries. The development of a task force for better demonstration of the golf-associated risks, especially among young children, is mandatory for preventing these unnecessary injuries.

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