# Parachute injuries in the Australian Airborne Battle Group in 2004

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## Abstract

- ***Objective:*** To examine current parachute injury rates, and compare these rates with Australian data from 1992, and with international data.
- ***Design and setting:*** Retrospective audit of static line and Ram Air Parachute Static Line (RAPSL) parachute operations by the Airborne Battle Group in 2004.
- ***Results:*** 21 of 378 personnel (5.6%) sustained an injury, for an overall injury rate of 15.3 per 1000 descents. The injury rate was higher for tactical exercise descents (32.6 per 1000 descents). These rates are about double those reported from 1992, and are higher than published international rates.
- ***Conclusions:*** Injury rates for military parachute descents in Australia appear to have increased over the past 15 years.


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AIRBORNE DEPLOYMENT allows the rapid projection of large numbers of troops over extensive distances, into remote and austere environments. The nature of such operations requires paratroopers to be mentally and physically tough, smart, and trained to operate on minimal resources for extended periods.

Parachute training is inherently dangerous, with a risk of injury at every stage of the parachuting sequence. The last formal research into Australian military parachute injuries was conducted in 1992.[1] Since then, there has been no process within the Airborne Battle Group to monitor injury rates and thus provide feedback into the system to guide equipment, personnel, and training requirements.

This article reports the findings of a retrospective study into static line injuries within the 3rd Battalion, Royal Australian Regiment (3 RAR), and A Field Battery (A FD BTY).

The parachute landing fall (Box 1) combines impact, collapse, and roll of the body.[2] The paratrooper grips the suspension lines, tucking the elbows firmly in front, with the chin held against the chest. Feet and knees are held tightly together with the hips and knees slightly flexed. During landing, there is a rapid distribution of energy through the body as the feet, then calves, thigh, buttocks, and back contact the ground. Momentum is washed off by the legs swinging over the body, resulting in the parachutist rolling from one side of the back to the other.[2]

## Methods

Data were obtained retrospectively from parachute manifest records of 3 RAR, for all descents in 2004 (January to December). All static line and Ram Air Parachute Static Line (RAPSL) descents of soldiers from 3 RAR and A FD BTY were included. All soldiers had successfully completed the basic parachute course at the Parachute Training School, with experience ranging from the first descent post course, up to 250 descents.

Unit medical records for all paratroopers identified from the manifest were retrospectively audited for any injuries recorded with "parachuting" as the mechanism of injury. The definition of an injury was one that resulted in evacuation from the drop zone, admission to a medical facility, withdrawal from an exercise, or restriction of duties.

Data collected included date of descent, drop zone, chute type, equipment carriage, night or day, method of aircraft exit, and activity type.

Descents are made in three primary dress and equipment configurations (Box 2). Combat equipment (CE) consists of clean fatigue (CF) dress plus combat webbing and an "Alice" pack. Combat equipment weights vary considerably between parachute continuation training (PCT) and tactical exercise descents (TEDs). TEDs are made during the deployment phase of an airborne field training activity, and soldiers are required to deploy with sufficient supplies to last up to 3 days. Soldiers are weighed to ensure the total weight of themselves, parachute, and combat equipment falls within the safe maximum load of the reserve parachute (159 kg).

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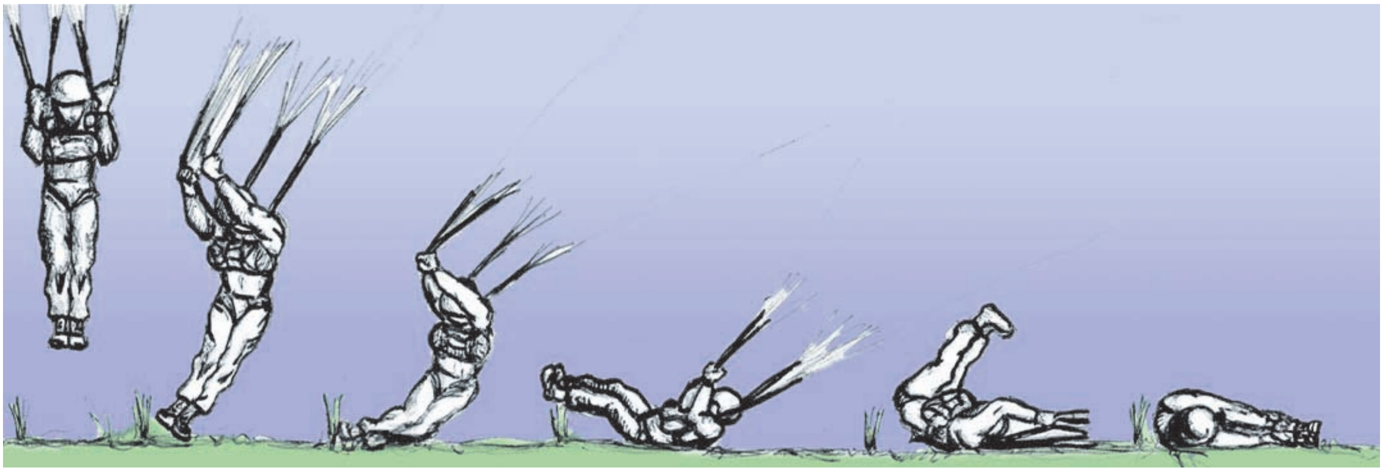
### 1 Parachute landing fall



## Results

From January to December 2004, 585 3 RAR and A FD BTY paratroopers conducted 1985 static line descents. Documents for 378 personnel were available for audit (64.6%), totalling 1375 descents (69.3% of total static line descents). All jumpers were men, and all descents occurred during daylight hours.

Descents comprised 49.1% PCT CF, 27.5% PCT CE, and 23.4% TEDs. All PCT descents were single-door exits, and all TEDs were simultaneous door exits onto tactical drop zones (DZ Hinge, Singleton, NSW; or DZ Bay Downs, Innisfail, Qld). Drop zone characteristics detailing temperature, wind speed, and wind direction were not available.

Twenty-one jumpers (5.6%) sustained an injury, with an overall injury rate of 15.3 per 1000 descents. Nine injuries (43%) required evacuation from the drop zone, eight (38%) required admission to hospital, and 17 (81%) required imaging. There were no fatalities. Injury rates did not significantly differ between PCT CF descents and PCT CE descents ($P = 1$, Box 3). However, there was a substantial increase in injury rates with TEDs ($P < 0.025$, Box 3).

Injury rates increased between 1992 and 2004, most significantly with PCT descents ($P < 0.05$; Box 4).

As detailed in Box 5, the most common sites of injury were the lower leg (38.1%) and back (28.6%). The injury distribution did not differ from those in previous reports,[1,3] except for an increased rate of shoulder injuries.

Forty-one paratroopers made 196 RAPSL descents. There was one injury, to the jumper's elbow, indicating a current injury rate of 5.1 per 1000 descents.

Injury rates were similar at DZ Hinge (33.9 per 1000 descents) and DZ Bay Downes (27.4 per 1000 descents) ($P = 1$).

### 2 Dress and equipment configurations for parachute descents

| Configuration | Dress | Helmet | Webbing | Pack |
|---|---|---|---|---|
| Parachute continuation training in clean fatigues (PCT CF) | DPCU, boots | Protech 1.1 kg | Nil | Nil |
| Parachute continuation training with combat equipment (PCT CE) | DPCU, boots | Protech 1.1 kg | Max 7 kg | Max 15 kg |
| Tactical exercise descent with combat equipment (TED) | DPCU, boots | Kevlar 6 kg | 10 kg; weapon 7 kg | 40 kg |

DPCU = disruptive pattern combat uniform.

### 3 Injury rates from 3 RAR and A FD BTY parachute operations, static line descents, January to December 2004

| Dress | Injury | No injury | Total | Injury rate (per 1000 descents) |
|---|---|---|---|---|
| Parachute continuation training in clean fatigues | 7 | 675 | 682 | 10.3 |
| Parachute continuation training with combat equipment | 4 | 352 | 356 | 11.2 |
| Tactical exercise descent with combat equipment | 10 | 327 | 337 | 32.6 |
| **Total** | **21** | **1354** | **1375** | **15.3** |

**4 Injuries sustained in static line descents — a comparison of Australian data**

| Study | Injury | No injury | Total | Injury rate (per 1000 descents) |
|---|---|---|---|---|
| **Parachute continuation training descents** | | | | |
| Farrow 1992[1] | 41 | 7517 | 7558 | 5.4 |
| This study | 11 | 1027 | 1038 | 10.6 |
| **Total** | **52** | **8544** | **8596** | **6.0** |
| **Tactical exercise descents** | | | | |
| Farrow 1992[1] | 22 | 1306 | 1328 | 16.6 |
| This study | 10 | 327 | 337 | 32.6 |
| **Total** | **32** | **1633** | **1665** | **19.2** |

## Discussion

The results of this study highlight the increased risk of injury when jumping with combat equipment. The addition of minimal weight CE does not increase the injury rate compared with CF descents during PCT. However, full loading of CE during TEDs significantly increases injury rates.

Box 6 details a number of factors contributing to the increased injury rate for TEDs, and, while they have been identified, it is not possible to quantify the effects of many of them. Only a small number of PCT descents were conducted on tactical drop zones, hence a true comparison of drop zone characteristics influencing risk was not within the scope of this study.

These figures represent the data required for health planners to adequately support Australian parachute activities. Of greatest note is the near universal requirement for imaging of parachute injuries. Currently, the hospital assigned to the Airborne Battle Group, the Parachute Surgical Team, does not deploy with x-ray facilities because of load limitations and the fragility of such equipment during parachute insertion.

Crude fracture rates have been poorly detailed in the literature; however, the fracture rate in this study compares favourably with published values.[7-9]

RAPSL landings require the paratrooper to flare the chute before impact, washing off speed, which enables the paratrooper to "step" onto the ground as with civilian parachuting. The principal difference is the addition of combat equipment weighing up to 50 kg. The injury rate of 5.1 per 1000 descents in this study is similar to the current civilian injury rate of 4.3 per 1000 descents.[3]

Comparison with results from 1992[1] indicates a trend to higher injury rates for TEDs in this study (32.6 v 16.6 per 1000 descents; $P < 0.2$). With regard to non-TEDs, there is a significant increase in rate of injury (10.6 v 5.4 per 1000 descents, $P < 0.05$). Overall, the injury rates in this study are almost three times the crude international rates[3] (15.3 v 5.61 per 1000 descents).

The main difficulty when comparing injury rates between studies is the dramatic variation in definition of an "injury", and the design of each study. To allow accurate comparison with previous Australian data, the definition of "injury" in this study was taken from that used by Farrow.[1] Injury definition bias aside, it is evident that current Australian parachuting practices are seeing an increased rate of injury reporting, most significantly in PCT CF descents, over the past 15 years. In fact, in 1992, the Australian PCT CF injury rate was 1.9 times crude international rates[3] (3.3 v 1.78 per 1000 descents); it is now 5.8 times the international rate (10.3 v 1.78 per 1000 descents).

Are we in fact injuring more soldiers? A change in injury reporting culture over the past decade is likely to account for some of the variation in injury rates between this study and rates in 1992.[1] Military personnel are encouraged to report all injuries immediately after occurrence, with a wider acceptance of "broken" soldiers among their peers. As a result, soldiers now seek management more often and earlier for injuries than in the past.

The small sample size plus the influence of wind and ground conditions, which were not controlled for in this study, are likely to account for some of the variation. The total number of descents conducted over similar periods indicates paratroopers are conducting fewer descents. While this decreases exposure to a potentially harmful event, it has seen a dramatic shift in the number of experienced paratroopers

**5 Distribution of injuries — a comparison of data**

| Body region | Injury numbers: This study | Distribution as percentage of total injuries: This study | Farrow 1992[1] | Bricknell and Craig 1999[3]* |
|---|---|---|---|---|
| Head and neck | 2 | 9.5% | 12.0% | 15% (0–19.4%) |
| Shoulder | 4 | 19.0% | 14.5% | 5% (0–14.5%) |
| Arm | 0 | 0 | 0 | 3% (0–5.0%) |
| Chest/abdomen | 0 | 0 | 0 | 1% (0–4.2%) |
| Back | 6 | 28.6% | 13.7% | 17% (5.8%–40.1%) |
| Leg | 8 | 38.1% | 50.4% | 45% (26.3–50.4%) |
| Other | 1 | 4.8% | 9.4% | 18% (0–33.3%) |

* Average rates for all studies reviewed, with ranges in parentheses.

**6 Factors contributing to increased injury risk with tactical exercise descents.**

**Equipment weight**

- Increases descent rate and thus produces greater forces on impact.[4]
- Increases oscillations as combat equipment is suspended beneath the paratrooper.[5]
- Creates a landing hazard as the feet can strike the pack, altering the parachute landing fall.
- Inclusion of weapon sling over left shoulder held firmly against the side by the parachute harness creates an obstacle for left-side landings.

**Tactical drop zone**

- Less frequent maintenance can lead to harder surfaces.
- Undulating ground can cause the paratrooper to land up or down a slope, increasing landing forces.
- More obstacles (trees, rocks, car tracks, creeks, kangaroos etc) than on training drop zones.

**Tactical exercise situation**

- Extended pre-flight preparation (and pre-descent anxiety) results in minimal sleep, dehydration and poor diet, resulting in fatigue.
- Inability to urinate in-flight and during rigging sequence results in paratroopers deliberately avoiding fluid intake, thus increasing dehydration and exacerbating fatigue.
- Extended in-flight rigging sequence combined with heavy combat equipment loads dramatically increases pre-descent overall energy and muscle fatigue, plus discomfort.
- Air sickness.
- Increased number of jumpers:
  - Increased number of jumpers exiting the aircraft has been shown to increase injury rates.[6] When the number of paratroopers exiting the aircraft increased from 1–22 to 23–64 to 65–90, injury rates increased from 1.0% to 1.4% to 2.6%. (In this study, the maximum exit number was 60).
  - Fatigue and discomfort increase because of reduced space in the aircraft for in-flight rig, with more preparation time required and thus more time under combat equipment load.
  - Larger number of paratroopers in the air increases the risk of collision and entanglement.

**Simultaneous exits**

- No specific evidence quantifying increased risk, but anecdotal increases in mid-air collisions and "air-steals".

**Wind limits**

- Maximum wind speed for tactical exercise descents (15 knots) is higher than for parachute continuation training (13 knots). However, all tactical exercise descents during 2004 were conducted well within safety limits (maximum 9 knots).

within the Airborne Battle Group. Unfortunately, there is no evidence to support the widely held view that greater jump experience reduces injury risk. However, it is evident that the more descents paratroopers perform, the greater their ability to assess wind direction, landing direction, and thus execute an efficient parachute landing fall. A more efficient parachute landing fall reduces injury risk.[2]

The trend to a higher injury rate is seen without any change to equipment or techniques, and despite controls to limit TED CE loads to the reserve maximum. Additionally, the drop zones used today do not differ significantly, and there has been no change to wind limits. So, what options are available to us to prevent further increases in the future? New chutes and protective equipment are both proven and viable options that could be purchased immediately for use by Australian paratroopers.

Low porosity chutes see a dramatic reduction in injury rates, by reducing descent rates and hence impact forces. A study in 1992 compared injury rates of the "standard" porosity parachute with a low porosity parachute in 8706 descents.[4] The low-porosity chute decreased descent rates by up to 23%, resulting in up to a 94% reduction in injuries.

As with previous studies, in this study the lower leg was the most common site of injury. The United States Army has developed an over-the-boot ankle brace, known as the parachutist ankle brace (PAB). In a study of 13 782 descents in 2000, use of a PAB led to a 67% reduction in the rate of ankle injuries (4.5 to 1.5 per 1000, $P < 0.002$), and a 55% reduction in the rate of ankle fractures (1.1 to 0.5 per 1000, $P = 0.3$).[10] Additionally, the number of days lost to medical restriction from ankle injuries was reduced by 78% (316 days per 1000 descents to 71 days per 1000 descents). However, the PAB did not reduce the rate of compression injuries to the ankle.

It is widely believed that ankle braces will only transfer forces higher, resulting in increased tibia and fibula fractures, plus knee injuries. However, Schumacher et al[10] concluded there was no influence on other injuries. In fact, the overall injury rate declined with PAB use (16.5 to 13.3 per 1000 descents).

It is evident that airborne capability training carries some element of risk of soldier attrition due to injury. However, does parachuting in fact have a higher injury rate than other forms of military training? Anecdotal evidence suggests not, with Regimental Aid Post presentations and rates of personnel in Medical Employment Classification 3 or 4 being consistently lower in 3 RAR than other units.

This study highlights the increased risk for injury with tactical exercise descents, tripling the risk of injury compared with clean fatigue descents. It also reveals a two-fold increase in reported injury rates over the past 15 years in Australia, with no significant shift in parachute procedures. While comparison with international data is difficult, it is evident that Australian parachute procedures lead to significantly more injuries than in other nations. Further collation of data is required to provide ongoing surveillance and presentation of more comprehensive injury rate statistics, especially for comparison with other forms of military training.

## Competing interests

None identified.

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