

# TOP14 Rugby Union collisions analysis: a new comparison of micro-technology and video analysis methods

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## Headline

Elite Rugby Union game play is characterized by high intensity running activity (high-speed running, accelerations, decelerations) and collisions (tackles, rucks, mauls and scrums). These collisions are considered to be crucial aspects to the outcome of games and contribute to player fatigue (1), physiological damage (2) and injuries (3).

Rugby Union players are generally classified as forwards or backs, with major differences between both of them in terms of physical and physiological requirements during a game. Backs cover more distance at high-intensity and perform more and longer sprints than forwards. In contrast, forwards cover less distance and higher proportion of low-intensity distance due to a higher involvement in collisions events, than backs (4).

Traditionally in Elite French Rugby Union (TOP14) (the first division of French professional rugby union competition), performance analysts tend to use video to report rugby collisions during a game. This method is considered as the “Gold Standard” for determining collision count, however it is a demanding job for the analyst. The final result can be impacted by potential human errors and with the inability to assess the intensity of the collisions (5).

Global positioning system (GPS) micro-technology is a potential alternative to quantify collision events. Previous studies that used this type of technology have attempted to quantify and qualify collisions in different rugby codes. Previous studies on this topic show conflicting results, indicating a high-level reliability when comparing expert video coding with GPS micro-technology (MinimaxX, Catapult) on rugby league (6, 7) in the 2010s. In rugby union, Reardon et al. previously showed that GPS micro-technology (10 Hz Vector S5, Catapult Innovations, Australia) is not an accurate method for detecting collisions, in 2016 (5). On the opposite, Tierney et al. observed that collisions assessed by GPS (10 Hz Apex, StatSports Group Limited, Northern Ireland) appeared as relevant and reliable information, in 2020 (8). Most of them exhibited higher collision numbers within the GPS micro-technology than video analysis. This difference may be due to accounted frequent occurrence of non-collisions events involving g force such as running, acceleration and deceleration. The reliability of GPS micro-technology is constantly increased and could increase the relevance of the data. An interesting question still remains in this context: where are we today in TOP14?

To summarise the position in the TOP14 today, French Rugby Union and the TOP14 have agreed to use the same GPS micro-technology to evaluate running performance. In fact, each club uses the same GPS micro-technology unit “Catapult Vector S7 GPS” (Catapult Sports, Melbourne, Australia). Concerning video analysis methods, two distinct processes stand out in the TOP14: the club conducts its own analysis or calls an independent data supplier (e.g AIA SPORTS,

OPTA or STATS PERFORM). Today, GPS micro-technology has evolved and we questioned if we could identify a potential correlation between GPS micro-technology data (Vector S7 GPS, Catapult Sports, Melbourne, Australia) and manufacturer data (AIA SPORTS) for collision events. Thus, a potential relationship could help practitioners gain time in performance analysis, and ultimately could enhance their quantification and qualification of the collisions performed by each player.

## Aim of the paper

The purpose of this study was to quantify and qualify the TOP14’s collisions by player positions and to investigate the potential relationship between GPS micro-technology data (Vector S7 GPS, Catapult Sports, Melbourne, Australia) and manufacturer data (AIA SPORTS) concerning collision events.

## Methods

### Athletes

Forty-three male professional Rugby Union players ( $27.3 \pm 3.7$  y;  $187.2 \pm 7.7$  cm,  $103.5 \pm 14.9$  kg) from the club of RCToulon participated in this study (forwards players,  $n=24$ :  $27.6 \pm 3.5$  y;  $189.5 \pm 7.8$  cm,  $114.4 \pm 6.9$  kg; backs players,  $n=19$ :  $26.9 \pm 4.1$  y;  $184.2 \pm 6.4$  cm,  $88.8 \pm 8.5$  kg). Therefore, ethics committee clearance was not required although consent was obtained from each participant. The study nevertheless conformed to the recommendations of the Declaration of Helsinki.

### Design

A retrospective analysis was performed on 17 games over the course of the TOP14 season 2022-2023. All matches took place between September 2022 and March 2023, played in different grounds throughout the France country, used by clubs playing in the TOP14. Altogether, 353 individual game-observations were collected. Collision counts are expressed in number per minute (n/min), and time is defined by the effective play duration (ball in play).

### Micro-technology method

Players wore a GPS micro-technology unit (Vector S7 GPS, Catapult Sports, Melbourne, Australia) carried in a bespoke pocket in their playing jersey during all games, positioned on the upper thoracic spine between the scapulae, during all

games. Each unit included a 100-Hz accelerometer, magnetometer, gyroscope and a 10-Hz GPS. From OpenField 3.10.1 (Catapult Sports, Melbourne, Australia), 10 Hz raw data were exported and analyzed. The selected event from Catapult GPS micro-technology unit among available parameters is “rugby union contact involvement”. This parameter is calculated via an algorithm, to identify impacts and to assess changes in posture; this latter combines the metrics from acceleration (using accelerometer) with rotation (using gyroscope) within the 3 planes of motion. The parameter also applies machine learning to identify specific rugby union impacts. 6791 events were registered during the ball in play. “Inertial Movement Analysis” (IMA) impact is a metric that was used to determine the magnitude in g force during the collision events. 1836 “rugby union contact involvement” out of 6791 events,

associated with IMA impact greater than 5 g were used. A single collision may result in multiple IMA impact, in these cases, the IMA impact with the greatest magnitude was retained.

**Video Analysis method**

The manufacturer AIA SPORTS provided analysis of all games of the season. Identification and quantification of collision events were undertaken in Sportscode™ (Sportstec by Hudl, Nebraska, USA). Selected events from AIA SPORTS chosen to characterized collisions are defined and presented in Table 1. 5551 events were registered (scrum actions are not considered) during ball in play time.

**Table 1. Events from AIA SPORTS chosen to characterized collisions.**

Collision Events	Collision Events Definition
Contact	when a ball carrier collides with an opposite player
Effective ruck	when a player cleans out an opposite defender in a ruck after a tackle
Defenders beaten	the ball carrier break through a tackle from a defending player
Counter Ruck	when one or more players take opposing players out of a ruck to earn possession
Contests	when the first player to reach a tackle area tries to grab the ball
Tackle	when the first player makes contact with an opposition ball-carrier
Assistant	when the second player makes contact with an opposition ball-carrier

**Analysis**

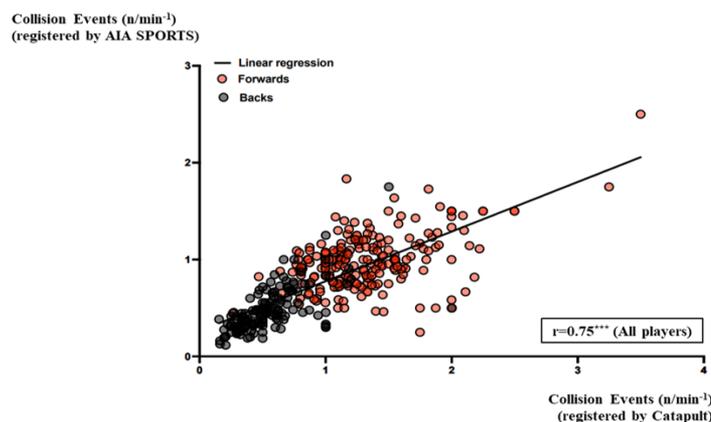
All data (GPS micro-technology and video analysis) were exported to Microsoft Excel (Microsoft Corporation, Washington, USA). Following storage, both sets of data were uploaded into RStudio software (R Core Team, 2022) for analysis and visualization. Data normality was ensured using Q-Q plot analysis to verify the homogeneity of variance. The difference between players’ position was tested for statistical significance using paired-samples T-tests. Pearson’s correlation coefficient (r) was computed to assess the association between the number of collisions identified through GPS micro-technology and those detected via video analysis, accompanied by 95% confidence intervals (CI). The magnitude of (r) was evaluated according to the recommendations of Hopkins et al. (9) as follows: r=0.0-0.09 (*trivial*), r=0.1-0.29 (*small*), r=0.3-0.49

(*moderate*), r=0.5-0.69 (*large*), r=0.7-0.89 (*very large*), r=0.9-0.99 (*nearly perfect*), r=1 (*perfect*).

**Results**

**Relationship between GPS micro-technology and video analysis methods**

A significant positive correlation was found between collisions tracked by GPS microtechnology (n=6791) and those identified through video analysis (n=5551) during TOP14 games. This association is substantiated with a Pearson correlation coefficient (r) of 0.75, and its magnitude is emphasized by a 95% confidence interval that ranges from 0.70 to 0.80. A graphical depiction of this linear regression is provided in Figure 1.



**Fig. 1. Pearson’s correlation for collision events coded by GPS micro-technology (Catapult) and video analysis (AIA SPORTS) for all players, during rugby union TOP14.**

### Collisions Quantification and Correlation

Collisions quantification coded by GPS micro-technology and video analysis for all, forwards and backs players, during ball in play in TOP14 games are provided in Table 2. Collision events were 1.02 ( $\pm$  0.54) and 0.79 ( $\pm$  0.37) per minute using GPS micro-technology and video analysis, respectively. Cor-

relation between GPS micro-technology and video analysis for all players is very large, for forwards players is moderate and for backs players is large. Independent from analysis type (GPS micro-technology or video analysis), the results showed a significant difference ( $p < .001$ ) between forwards and backs concerning collision events.

**Table 2. Quantification and correlation of collision events coded by GPS micro-technology (Catapult) and video analysis (AIA SPORTS), for all players, forwards and backs players, during rugby union TOP14.**

	Collision events (n/min-1 $\pm$ SD) by GPS micro-technology (Catapult)	Collision events (n/min-1 $\pm$ SD) by video analysis (AIA SPORTS)	r	p	CI (95%)
All players (n=43)	1.02 ( $\pm$ 0.54)	0.79 ( $\pm$ 0.37)	0.75	< .001	0.70 – 0.80
Forwards players (n=24)	1.34 ( $\pm$ 0.44) <sup>a</sup>	0.99 ( $\pm$ 0.29) <sup>a</sup>	0.48	< .001	0.37 – 0.58
Backs players (n=19)	0.55 ( $\pm$ 0.27)	0.48 ( $\pm$ 0.23)	0.64	< .001	0.53 – 0.73

Legend: Values are mean  $\pm$  SD; SD=standard deviation; r= pearson product moment correlation coefficient value for the average number of collisions coded by the GPS micro-technology and video analyst; p= p value; CI= confidence interval; <sup>a</sup>= significantly different from backs players (t-test p-value ( $p < .001$ )).

### Collisions Qualification

Collisions qualification monitored using GPS micro-technology for all players, during ball in play time in TOP14 games are provided in Table 3. Rugby union players were subjected to collisions corresponding to a mean force intensity of 8.1 ( $\pm$  2.6) g concerning the 1836 “rugby union contact involvement” associated with IMA impact greater than 5 g. The results showed

a significant difference ( $p < .001$ ) between forwards and backs players concerning mean force intensity (7.8 vs. 8.5 g force). When analysed to find the mean of the maximum collision intensity, it was found that rugby union players received 14.8 ( $\pm$  2.4) g force (14.1 for forwards and 15.7 for backs) without significant difference between forwards and backs players.

**Table 3. Qualification of collision events coded by GPS micro-technology (Catapult) for all players, forwards and backs players, during rugby union TOP14.**

	Collisions mean intensity (g force) $\pm$ SD	Mean of maximal collisions intensity (g force) $\pm$ SD
All players (n=43)	8.1 ( $\pm$ 2.6)	14.8 ( $\pm$ 2.4)
Forwards players (n=24)	7.8 ( $\pm$ 2.4) <sup>a</sup>	14.1 ( $\pm$ 2.1)
Backs players (n=19)	8.5 ( $\pm$ 2.9)	15.7 ( $\pm$ 2.5)

Legend: Values are mean  $\pm$  SD; SD=standard deviation; <sup>a</sup>=significantly different from backs players ( $p < .001$ ).

### Discussion

The main findings of the current research based on the TOP14 rugby union games indicate 1) a clear relationship between collision events monitored by GPS micro-technology (Catapult) and the collision counts coded by video analysis (AIA SPORTS), and 2) that collisions mean intensity are more intense for backs than forwards players although forwards undergo more collisions than backs players.

1. The strength of the correlation between collision events monitored by GPS micro-technology and the collision counts coded by video analysis in TOP14 rugby union game may provide a methodological alternative to the manual coding of collisions using video analysis. Although the (r) value is better for backs than for forwards, this correlation was observed regardless of the player position. Pre-

vious literature has alluded to the fact that the detection of rugby union game collision is influenced by player position may be due to the different type of collisions that they are engaged in (5). For more accuracy, the same author insists on the incorporation of position specific individualization of collision thresholds. This is the case in our study using “rugby union contact involvement” from Catapult’ GPS micro-technology. This parameter is calculated via an algorithm combining the metrics from acceleration (using an accelerometer) with rotation (using a gyroscope) within the 3 planes of motion. Potentially this process has improved collision detection by reducing a possible false positive event (as described in other studies). However, we observed during the monitoring of specific skills, organised by strength and conditioning coaches, high-accelerations ( $>4.0m.s^{-2}$ ) and « down and up », could be confounded

variables when considering collision events (personal observations). These actions incorporate g force and tilt in body orientation without a collision event. This observation could explain the difference in event count between GPS micro-technology and video analysis. Further TOP14 research is required in this area.

2. Values in collision mean intensity are more elevated for backs compared to forwards, although these latter undergo more collisions than backs players in TOP14 rugby union games. A research consensus exists to explain that rugby union forward players experience more collisions than backs (10,11,12). In our study specific to the TOP14, our results presented in Table 2 are consistent with the previous findings. Backs perform frequent bouts of acceleration, deceleration and high-speed running while forwards participate in more physical collisions such as tackling and semi-static actions including scrums, rucks and mauls. It is the nature of rugby that leads to this, with specific actions imposed by the players' position. To our knowledge, this case study is the first to report that values in collision mean intensity are more important for backs than forwards in the TOP14. It has been also well reported that backs move more during games at higher velocities and spend more time in high-speed running than forwards. This makes it more likely that backs would undergo higher velocity collisions than forwards (13). We might have thought that these high-speed levels would result in greater collisions intensity for the backs than for the forwards, but this is not the case. To explain this, we can hypothesize that at high-speed levels, players are trying to avoid an opposite player, they are not necessarily searching to make contact.

In this case study purely methodological, the results are likely to be/or not misaligned with other studies (5,6,7,8) because results depend on rugby codes combined with different GPS unit and accelerometer associated. This study provides new insight in the literature currently available and presents an interest to coaches and staff preparing TOP14 games. Future research is required to investigate 1) the factors that may be responsible for differences between GPS micro-technology and video analysis collision counts (with a particular focus on the different collision types including tackles, rucks, mauls...) and, 2) whether collision events and collision intensity experienced by rugby union players are in line with the data coming from instrumented mouthguards (which should be used soon in the TOP14) and influences their risk of incurring injuries.

### Practical Applications

Based on our own work, we provide three recommendations for performance analysts but also and strength and conditioning coaches:

- A strong relationship between GPS micro-technology and video analysis methods to count collision events may offer an alternative to the manual coding of collisions by the performance analyst.
- We think that training should mimic game physical demands and consider playing positions. For that, collision counts could be used by practitioners to quantify and to adapt the demands of training in order to optimally prepare players optimally for the collisions that they might undergo during a game.
- Position-specific collision counts could be used to enhance the prescription of rehabilitation training during the return-to-play phase following injury.

### Limitations

This case study is not without limitations. Firstly, it should be noted that consideration of ground and surface conditions were not included in the current study. The firmness of the ground could have a substantial influence on the magnitude of collisions and should be considered in future research (8). Secondly, this analysis of a single team's performance might not be transferrable to all teams of TOP14, due to the high inter-player variability linked to different playing styles and training practices.

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