ORIGINAL ARTICLE

Muscle injuries in the academy of a Spanish professional football club: A one-year prospective study

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KEYWORDS
Epidemiology;
Hamstring;
Adductors

Abstract
Introduction: Due to its high incidence, muscle injury is one of the major problems for football players. The aim was to analyse the rate and characteristics of muscle injuries in the academy of a Spanish professional football team (Spanish First Division) during a complete competitive season (2015–2016) using a prospective cohort design.

Material and methods: Time-loss injuries and exposure time were recorded following the UEFA consensus in 139 elite young football players from 4 levels (Senior, U19, U16 and U14) over one season.

Results: A total of 118 injuries were recorded. Overall injury incidence was 1.47 muscle injuries/1000 h, with a lower incidence in younger players. Nevertheless, injury burden (days lost/1000 h) was similar between levels. The injuries with the highest incidence and burden were hamstring and adductor injuries in Senior (50 and 58 days respectively), hamstring injuries in U19 and U16 (109 vs 89), and adductor injuries in U14 (175 days). Regarding the severity of injuries, it was observed that moderate injuries were the most common injuries and muscle injuries during competition had a higher incidence towards the end of the matches (75–90°).

Conclusions: Muscle injury prevention strategies are necessary in players from all levels and should be adapted to their specific needs, with hamstring and adductor injuries being the main problem in the present study.

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Lesiones musculares en las distintas categorías de un club profesional de fútbol
Español: estudio prospectivo de una temporada

Resumen

Introducción: Debido a su elevada incidencia, las lesiones musculares son uno de los principales
problemas para los futbolistas a lo largo de su carrera profesional. El objetivo de este estudio
fue analizar la incidencia lesional y las características de las lesiones musculares de la cantera
de un equipo de fútbol profesional (primera división española) durante una temporada completa

Material y métodos: Se registraron las lesiones y el tiempo de exposición de 139 jugadores de
fútbol de 4 categorías (sénior, U19, U16 y U14) durante una temporada siguiendo los criterios
UEFA.

Resultados: Un total de 57 lesiones musculares fueron registradas. La incidencia lesional fue
de 1,47 lesiones musculares/1.000 h, siendo esta incidencia menor cuanto menor era la cate-
goría. No obstante, las consecuencias en forma de días de baja/1.000 h fueron similares entre
categorías. Las lesiones más comunes y las que produjeron el mayor número de días de baja
fueron las de isquiosurales y aductores en los sénior (50 y 58 días, respectivamente), las de
isquiosurales en U19 y U16 (109 vs. 89 días), y las de aductores en U14 (175 días). Además,
las lesiones moderadas fueron las más comunes y las lesiones musculares producidas en competición
tuvieron una mayor incidencia hacia la fase final de los partidos (75-90 min).

Conclusiones: Las estrategias preventivas de lesiones musculares son necesarias en futbolistas
de todas las categorías y deben ser adaptadas a sus necesidades específicas, siendo las lesiones
de isquiosurales y aductores el mayor problema para los jugadores del presente estudio.

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Introduction

Injuries are now a major cause of concern for football clubs. This is because they have been shown to reduce team
top performance, have a high economic cost and may lead to long-term health problems. Muscle injuries are one of
the main problems faced by footballers throughout their professional career. They now amount to approximately
54% of the total number of injuries suffered by high level foot-
ball players, although the corresponding percentage for
semi-professional players is lower. This is shown in the
results of a recent study, in which it was found that about
15 muscle injuries per season could be expected in a club
with 25 players. It also has to be taken into account that
these injuries are not uniformly distributed among the 4
main muscle groups (ischiocrural, quadriceps, adductor and
calf muscles), as most injuries occur to the ischiocrural and
adductor muscles, so that this notably hinders the task of
preventing muscle injuries.

Due to the significant differences between the incidence
of injuries in players at different levels, it is advisable to
commence the process of preventing injuries on the basis
of an epidemiological analysis of the category in question. This
is why many previous studies have been conducted in recent
years, the majority of which cover high level international
players. Nevertheless, there are few studies of Spanish
team epidemiology. Noya et al. studied the incidence of
injuries in 16 Spanish first division clubs, showing that mus-

cle injuries account for 53.8% of all the injuries suffered by
these players in a year. On the other hand, Mallo et al. studied
the specific epidemiology of Spanish semi-professional

players. The results showed that the most common muscle
injuries are to the ischiocrural muscles (1.0 injury/1000 h
exposure). In spite of the valuable information supplied by
these previous studies, there is very little information on the
incidence of injuries among young players. The work by
Price et al. stands out, in which the injury rate in the young
players of 38 professional English clubs was studied over two
complete years. During this time muscle injuries were the
most common (39%), and as was the case with the results of
previous studies with senior footballers, the ischiocrural
muscles suffered the highest percentage of injuries.

Although the epidemiology of injuries has been studied in
deepth in footballers at different levels, the authors believe
that to date the incidence of muscle injuries in the young
players of a professional club in Spain has not been studied.
As there are a great many young players in Spain, it would
be important to learn the epidemiological characteristics of
the young players in a Spanish football team to optimise
preventive strategies and reduce the incidence of injuries
in this population. This study therefore analyses the rate
of muscle injuries and their characteristics in a professional
football team during a whole season.

Methods

Participants

139 young players in a professional football club took part in
this study. More specifically, they belonged to 7 different
teams which were grouped into categories (senior, U19,

PALABRAS CLAVE
Epidemiología;
Isquiosurales;
Aductores
Muscle injuries in the academy of a Spanish professional football club

U16 and U14). There were 14 goalkeepers in the sample, together with 28 centre backs, 27 left and right backs, 28 centre midfield players, 27 wide midfield players and 15 forwards.

Before starting the study the participants were informed about the protocol that would be followed, and their informed consent forms were filled in by their parents in the case of minors. The older participants signed their own informed consent documents. Procedures were followed according to the ethical standards recommended by the Helsinki Declaration (2013). All of the participants were free to abandon the study at any time and without any penalty.

Procedures and definitions

A prospective study was undertaken of cohorts of the young players in a professional football team (in the first division, Spain) throughout the 2015–2016 season. During the study the coach of each team was in charge of recording the data on injuries in their team during training as well as matches. All data were supervised by the club coaches coordinator. Muscle injuries were recorded using a standardised and computerised questionnaire based on the UEFA criteria for epidemiological studies.10 This recorded information on the date an injury occurred and when the player recovered, together with the type, location and severity of the injury and the number of days the player was on sick leave, the injury mechanism and diagnosis, and whether it occurred during training or while competing. Injury was defined as follows: “an injury that occurs during a training session or match and which causes the player to be out of the next training session or match”’.10 Footballers were considered to be fully recovered from an injury after a session when the medical staff stated that they were ready to fully take part in the next training session or match. A relapse was defined as an injury that occurred after an initial one of the same type and location.10 Injuries were classified according to severity as light (1–3 absence days), slight (4–7 days), moderate (8–28 days) and severe (>28 days). Types of muscle injury were divided according to the damaged muscle group, based on the 4 groups that suffer the highest rate of football injuries (ischiofemoral, quadriceps, adductors and calf).1 Exposure time during training and matches (friendly and competitive) was recorded every day in minutes.

Statistical analysis

Injury incidence is shown as the number of injuries/1000 h, with a confidence interval (CI) of 95%, and the number of absence days/1000 h was calculated with a 95% CI.11 The incidence of injuries and the number of absence days/1000 h were compared for the different categories by calculating the incidence ratio (IR) with a 95% CI, and using the Z-test.11 The differences between the categories respecting player characteristics and exposure time were calculated using Student’s t-test. The level of significance was set at P < .05, and statistical analysis was performed using Microsoft Excel 2011 software (Microsoft, Redmond, WA, USA) and GraphPad Prism v.6.0c (GraphPad Software, La Jolla, CA, USA).

Results

Exposure time and injury incidence

Participants’ anthropometric data and exposure time are shown in Table 1. There were no significant differences between the categories in terms of exposure time. Table 2 shows the number of muscle injuries and the incidence of injuries in the different muscle groups. A total of 57 muscle injuries were recorded in this study, with a total incidence of muscle injuries of 1.47 muscle injuries/1000 h (0.89/1000 h training vs 6.47/1000 h competition). The incidence and number of muscle injuries varied depending on category, with a lower incidence in the younger categories. Ischioural injuries were the most common in the senior, U14 and U16 categories, while adductor injuries were the most common in the U14 category, and they were as common as ischioural injuries in the senior category. Only 2 relapses were recorded during the whole study, amounting to 3.5% (2/57) of the total number of muscle injuries. Additionally, injuries caused by overuse were more common (52/57) than those in which the cause of injury was traumatic (5/57).

Severity and absence days

The number of absence days during the season and the severity of injuries in the different player categories are shown in Table 3. The muscle injuries recorded in this study led to a total of 759 absence days, and on average each injury resulted in players taking 13 ± 11 absence days (median = 11, range = 1–53 days). More specifically, the injuries that led to the most absence days in the senior players were those to the ischioural and adductor muscles, the ischioural muscles in the U19 and U16 and the adductors in the U14 group. In terms of severity moderate injuries were the most common (32/57) and severe ones were the least common (5/57). Table 3 shows how absence days/1000 h varies significantly depending on player category and muscle group.

Injury distribution

The 57 injuries recorded throughout the season were distributed in the following way: 13 in the pre-season, 21 in the first half of the season and 23 during the second half of the season. Fig. 1 shows the muscle injury distribution data according to player position and category. On the other hand, Fig. 2 shows the moment in matches when injuries occurred, and the highest number of injuries selected for this study (11/26) occurred during the final part of matches (75–90). In fact, the incidence of injuries during the last 15 minutes of matches (16.43/1000 h) was more than 3 times higher than the incidence in the rest of the match (4.48/1000 h, IR = 3.67, 95% CI 1.68–7.98).

Discussion

The main novelty of this study is that it analyses the incidence of muscle injuries and their characteristics in the young players of a professional football team during a complete season, comparing them with the injuries suffered
Table 1  Participant data, average ± SD.

<table>
<thead>
<tr>
<th></th>
<th>Senior</th>
<th>U19</th>
<th>U16</th>
<th>U14</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of players</strong></td>
<td>22</td>
<td>40</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>21.7 ± 1.8</td>
<td>17.5 ± 1.1</td>
<td>14.4 ± 1.9</td>
<td>12.77 ± 1.5</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>181.7 ± 0.1</td>
<td>177.2 ± 6.1</td>
<td>172.5 ± 3.9</td>
<td>165.9 ± 4.1</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>78.2 ± 6.3</td>
<td>70.1 ± 5.8</td>
<td>61.2 ± 5.5</td>
<td>49.3 ± 3.7</td>
</tr>
<tr>
<td><strong>Body mass index (kg/m²)</strong></td>
<td>22.1 ± 1.8</td>
<td>22.3 ± 2.1</td>
<td>20.6 ± 1.7</td>
<td>17.9 ± 1.5</td>
</tr>
<tr>
<td><strong>Exposure time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total hours</td>
<td>8033</td>
<td>12,738</td>
<td>9372</td>
<td>8766</td>
</tr>
<tr>
<td>Training hours</td>
<td>7290</td>
<td>11,620</td>
<td>8250</td>
<td>7809</td>
</tr>
<tr>
<td>Match hours</td>
<td>743</td>
<td>1,118</td>
<td>1,122</td>
<td>957</td>
</tr>
<tr>
<td>Total hours per player</td>
<td>382 ± 42</td>
<td>318 ± 35</td>
<td>240 ± 26</td>
<td>225 ± 25</td>
</tr>
<tr>
<td>Training hours per player</td>
<td>347 ± 31</td>
<td>289 ± 26</td>
<td>211 ± 19</td>
<td>200 ± 18</td>
</tr>
<tr>
<td>Match hours per player</td>
<td>35 ± 13</td>
<td>28 ± 10</td>
<td>29 ± 10</td>
<td>25 ± 9</td>
</tr>
</tbody>
</table>

Table 2  The incidence of muscle injuries in the different categories of a professional football club.

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Total</th>
<th>Training</th>
<th>Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Incidence/1000 h</td>
<td>95% CI</td>
</tr>
<tr>
<td><strong>Muscle injuries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>19</td>
<td>2.36a</td>
<td>1.51–3.71</td>
</tr>
<tr>
<td>U19</td>
<td>18</td>
<td>1.41</td>
<td>0.89–2.24</td>
</tr>
<tr>
<td>U16</td>
<td>12</td>
<td>1.28</td>
<td>0.73–2.25</td>
</tr>
<tr>
<td>U14</td>
<td>8</td>
<td>0.91</td>
<td>0.46–1.82</td>
</tr>
<tr>
<td><strong>Ischiocrural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>6 (32)</td>
<td>0.75</td>
<td>0.34–1.66</td>
</tr>
<tr>
<td>U19</td>
<td>8 (44)</td>
<td>0.63</td>
<td>0.31–1.26</td>
</tr>
<tr>
<td>U16</td>
<td>5 (42)</td>
<td>0.53</td>
<td>0.22–1.28</td>
</tr>
<tr>
<td>U14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quadriceps</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>1 (5)</td>
<td>0.13</td>
<td>0.02–0.88</td>
</tr>
<tr>
<td>U19</td>
<td>2 (11)</td>
<td>0.09</td>
<td>0.12–0.98</td>
</tr>
<tr>
<td>U16</td>
<td>2 (17)</td>
<td>0.21</td>
<td>0.05–0.85</td>
</tr>
<tr>
<td>U14</td>
<td>1 (13)</td>
<td>0.12</td>
<td>0.02–0.81</td>
</tr>
<tr>
<td><strong>Adductor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>6 (32)</td>
<td>0.75</td>
<td>0.34–1.66</td>
</tr>
<tr>
<td>U19</td>
<td>2 (11)</td>
<td>0.16</td>
<td>0.04–0.63</td>
</tr>
<tr>
<td>U16</td>
<td>1 (8)</td>
<td>0.11</td>
<td>0.02–0.76</td>
</tr>
<tr>
<td>U14</td>
<td>5 (63)</td>
<td>0.57</td>
<td>0.24–1.37</td>
</tr>
<tr>
<td><strong>Calf</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>4 (21)</td>
<td>0.50</td>
<td>0.19–1.33</td>
</tr>
<tr>
<td>U19</td>
<td>3 (17)</td>
<td>0.24</td>
<td>0.08–0.73</td>
</tr>
<tr>
<td>U16</td>
<td>1 (8)</td>
<td>0.11</td>
<td>0.02–0.76</td>
</tr>
<tr>
<td>U14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI: confidence interval; *P* < .05.

a Ratio significantly higher than it is for U16.
b Ratio significantly higher than it is for U14.

by the corresponding senior team. The results obtained show that the younger footballers suffered a lower rate of injuries, although their consequences (absence days/1000 h) were similar in all of the categories. These results also show that the most common injuries and the ones which led to the largest number of absence days were to the ischiocrural muscles and adductors in the senior players, the ischiocrural muscles in the U19 and U16 categories, and the adductors in the U14 category. The majority of injuries occurred in the final 15 min of matches.
Table 3 Absence days due to injuries according to location and type, in the different categories of a professional football club.

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Total absence days</th>
<th>Absence days/1000 h</th>
<th>Median absence days per injury (range)</th>
<th>Severity (number of injuries)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Light (1–3 days)</td>
</tr>
<tr>
<td><strong>Muscle</strong></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Senior</td>
<td>170</td>
<td>21</td>
<td>8 (1–19)</td>
<td>3</td>
</tr>
<tr>
<td>U19</td>
<td>236</td>
<td>19</td>
<td>14 (3–40)</td>
<td>3</td>
</tr>
<tr>
<td>U16</td>
<td>162</td>
<td>17(^a)</td>
<td>9 (2–31)</td>
<td>2</td>
</tr>
<tr>
<td>U14</td>
<td>191</td>
<td>22</td>
<td>16 (12–53)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Ischiocrural</strong></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Senior</td>
<td>50</td>
<td>6</td>
<td>8 (3–17)</td>
<td>3</td>
</tr>
<tr>
<td>U19</td>
<td>109</td>
<td>9</td>
<td>12 (3–40)</td>
<td>1</td>
</tr>
<tr>
<td>U16</td>
<td>89</td>
<td>10(^a)</td>
<td>10 (2–39)</td>
<td>1</td>
</tr>
<tr>
<td>U14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td><strong>Quadriceps</strong></td>
<td></td>
<td></td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Senior</td>
<td>8</td>
<td>1</td>
<td>8</td>
<td>–</td>
</tr>
<tr>
<td>U19</td>
<td>20</td>
<td>2</td>
<td>10 (5–15)</td>
<td>–</td>
</tr>
<tr>
<td>U16</td>
<td>18</td>
<td>2</td>
<td>9 (7–11)</td>
<td>–</td>
</tr>
<tr>
<td>U14</td>
<td>16</td>
<td>2</td>
<td>16</td>
<td>–</td>
</tr>
<tr>
<td><strong>Adductor</strong></td>
<td></td>
<td></td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Senior</td>
<td>58</td>
<td>7(^a)</td>
<td>11 (1–18)</td>
<td>2</td>
</tr>
<tr>
<td>U19</td>
<td>34</td>
<td>3(^c,d)</td>
<td>17 (13–21)</td>
<td>–</td>
</tr>
<tr>
<td>U16</td>
<td>2</td>
<td>0.2(^a)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>U14</td>
<td>175</td>
<td>11(^b,(^a)</td>
<td>14 (12–47)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Calf</strong></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Senior</td>
<td>36</td>
<td>4(^c)</td>
<td>7 (2–19)</td>
<td>1</td>
</tr>
<tr>
<td>U19</td>
<td>49</td>
<td>4(^c)</td>
<td>19 (17–20)</td>
<td>–</td>
</tr>
<tr>
<td>U16</td>
<td>8</td>
<td>1</td>
<td>8</td>
<td>–</td>
</tr>
<tr>
<td>U14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^a\) Ratio significantly higher/lower than it is for senior (P < .05).
\(^b\) Ratio significantly higher/lower than it is for U19 (P < .05).
\(^c\) Ratio significantly higher/lower than it is for U16 (P < .05).
\(^d\) Ratio significantly higher/lower than it is for U14 (P < .05).

The total injury rate in young elite players in our study (1.47 muscle injuries/1000 h) was lower than the rate detected in national and international professional footballers.\(^2\) The results for injuries during training were lower (0.89 muscle injuries/1000 h vs 1.38 muscle injuries/1000 h), than they were for competition (6.47 injuries/1000 h vs 9.58 injuries/1000 h).\(^2\) These differences may be influenced by the large number of games which professional players at UEFA level have to play in a short period of time.\(^13\) When the results of our study are analysed according to category, the number of muscle injuries and the total incidence of injuries were found to be lower in the younger categories. These findings may be due to the influence of age as an intrinsic risk factor that mainly affects muscle injuries.\(^1\) This was shown previously in the study by Price et al.,\(^9\) which also covered elite young players. Although the injury rate is higher in older players, the number of absence days/1000 h was similar in the different categories. It therefore seems that the younger players suffer more severe injuries, or ones that require more time to recover. This may be due to the possibility that, even though they are young players in a professional club, the human and material resources used in preventing and recovering from injuries are insufficient. It is interesting to examine the fact that the highest number of absence days/1000 h occurred in the U14 category. This may be explained by their lack of strength, as they have yet to adapt to the demands of competition.\(^15\) This leads to more severe injuries, as strength-increasing preventive programmes have been shown to not only reduce the injury rate, but also have the secondary aim of reducing the severity of muscle injuries.\(^16\) Strategies to prevent muscle injuries are therefore necessary in all categories, and it is recommendable to spend more time and resources on injury prevention and recovery for younger footballers.

Regarding the distribution of muscle injuries in the different categories, as was the case in previous studies\(^1–4,9\), the ischiocrural muscles suffered the highest number of injuries. Nevertheless, the U14 footballers suffered no injury of this type. In this study the absence of ischiocrural muscle injuries seems to be justified by the fact that at these ages footballers do not run at high speeds in training or when...
Figure 1 Distribution of muscle injuries according to player position and category (PT: goalkeeper, DF: centre back, DL: right or left back, CC: midfielder player, CB: midfield wing, DC: forward).

Figure 2 Distribution of muscle injuries in match playing time.

...and multiplies by 7 times the possibility of suffering an adductor muscle injury, and by 2 times the possibility of suffering an adductor and ischiocrural muscle injury, and by 5 times the possibility of suffering an adductor and ischiocrural muscle injury. The two groups of muscles being the ones that suffer the highest number of relapses in football.22,23 There were only two relapses in our study, affecting the ischiocrural and calf muscles. The percentage of relapses in young elite players was lower (3.5%) than it was in national and international level professional footballers, at 24.4% and 16.4%, respectively. These results may be influenced by the pressure in elite clubs on medical departments to achieve the rapid return of injured players to routine team training, leading to insufficient physical and sports adaptation.

Although no significant differences were found between the muscle injuries suffered by players in different positions, it is important to underline that these muscle injuries were not distributed uniformly among the different specific positions and categories. This information may be a great help for trainers and sports directors when forming teams. As was found in previous epidemiological studies, the majority of injuries occur during the final part of matches (75–90') due to the fatigue suffered by footballers at this time.

The chief limitation of this study is that it analyses teams belonging to a single football club, so that it is possible that the results cannot be extrapolated to other clubs. Given the high injury rate and the large number of absence days in young footballers, studies are needed that include multiple professional club academies and last for several seasons. This evidence would make it possible to optimise injury prevention programmes, promoting the healthy practice of football among young players and increasing their possibilities of becoming professional footballers.

Conclusions

The main findings of this study were that although younger footballers suffer fewer injuries, the number of absence days/1000 h was similar in the different categories. The most common injuries and the ones that led to the highest number of absence days in the senior category were to the ischiocrural and adductor muscles. This was so for ischiocrural injuries in the U19 and U16 categories, and the adductor muscles in the U14 category, while the majority of injuries occurred in the final 15 min of matches. This information may be very useful for trainers and medical staff for the development of effective prevention strategies to reduce the incidence and severity of muscle injuries in young Spanish elite footballers.

Conflict of interests

The authors have no conflict of interests to declare.

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