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Estimated Economic Losses Caused by Umbilical Lesions in Calves

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Abstract

This study aimed to determine the incidence rates of umbilical lesions and the estimated economic loss caused by umbilical lesions in calves in accordance with the data obtained from 683 umbilical lesion cases brought to Kafkas University Faculty of Veterinary Medicine Research Hospital in the last 15 years and the Delphi survey conducted with specialized veterinarians. In the study, 46.1% of the 683 calves with umbilical lesions were diagnosed with hernia, 39.8% with omphalitis, 10.4% with abscess and 3.7% with urachus fistula. It was determined that approximately 40% of the lesions occurred in March and April, which is the birth season, and 54.8% of the calves were younger than 30 days old. In the study, the incidence rate of umbilical lesions was 38.6%, the success rate of the operations was 73.9%, the probability of postoperative complications was 28.9% and 53.8% of the calves were reformed after the operation. In the study, the economic loss per calf was estimated to be 245.6 \$/head on average and the estimated annual loss due to the operation of umbilical lesions in Turkey was estimated to be 88 million 660 thousand \$. As a result, while umbilical lesions, except hernia umbilicalis, can be eliminated with simple preventive measures after birth, it was determined that umbilical lesions cause significant economic loss due to diagnosis and treatment fees, operation and postoperative care costs, as well as developmental retardation, patient transportation fees, labor loss spent on sick animals and postoperative complications.

Key Words: Economic loss, omphalitis, operation, postoperative cost, umbilical lesions

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Introduction

In livestock farms, the healthy birth and growth of the calf is one of the most important factors for the continuity and profitability of the enterprise and is reported to increase the enterprise income by 35-40% (Erez & Göncü, 2012). For this reason, care and feeding should be paid attention from birth for the healthy growth of new-borns, because newborn calves are more susceptible to diseases than adults, and care and feeding errors in the first period of their lives affect their survival and future performance (Demir Ayvazoğlu *et al.*, 2019; Akman & Şen, 2016). Recently, as dairy cattle farms have developed in Turkey, there has been a significant increase in the number of calves brought to clinics. Umbilical lesions (omphalitis, omphalophlebitis, omphaloarteritis, urachal fistula, hernia umbilicalis, umbilical abscess, evantratio umbilicalis) that occur for various reasons after birth in new-born calves are among the most common diseases (Guerra *et al.*, 2020; Yurdakul *et al.*, 2021b).

It has been reported that umbilical lesions have a high rate of 47% among calf surgical diseases and environmental and infection factors play a role in their etiology (Görgül *et al.*, 1991). Especially in the formation of umbilical lesions; many factors such as unfavourable environmental conditions at the time of birth and after birth, cutting and cleaning the umbilical cord without sufficient length and hygienic conditions, unhygienic shelter environment, hereditary reasons, general condition disorder, not enough colostrum, cachexia are effective (Ayvazoğlu *et al.*, 2020; Sağlıyan *et al.*, 2016; Yurdakul *et al.*, 2021).

In addition to economic losses resulting in high treatment costs and calf loss, umbilical lesions of new-born calves cause developmental retardation and meat, milk and/or reproductive efficiency losses in later periods, negatively affecting the livestock sector as well as business profitability (Ayvazoğlu Demir *et al.*, 2019). In this context, in this study, it was tried to determine the incidence rates of umbilical lesions in calves and the estimated economic loss caused by umbilical lesions in calves with a Delphi survey conducted with 683 cases that came to the research hospital in the last 15 years with the complaint of umbilical lesions.

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57 Materials and Methods

58 The study material consisted of the data of 683 calves of different breeds and sexes brought to Kars
59 Kafkas University Faculty of Veterinary Medicine, Faculty of Veterinary Medicine, Department of Surgery
60 between 2007 and 2022 with the complaint of umbilical lesions. Data were analysed using SPSS (IBM SPSS
61 Statistics 20) package program. Frequency tables and descriptive statistics were used to interpret the findings
62 and the statistical relationship between the incidence of umbilical lesions and categorical data such as sex,
63 breed, age and season were analysed by chi-square method.

64 In the study, a Delphi Survey was conducted with 25 specialized veterinarians to obtain various
65 information and data needed to determine the estimated economic loss caused by umbilical lesions. Based on
66 the data obtained, the economic losses caused by umbilical lesions were calculated. With the average,
67 minimum and maximum values obtained from the Delphi Survey, estimated economic losses were calculated
68 with three different scenarios: optimistic, expected and pessimistic. Table 1 shows the parameters and formula
69 used to determine the estimated economic loss.

70 **Table 1** Parameters and formula used to determine the estimated economic loss

Parameters	Value (Min-Max)	Literatur
Total number of calf in Türkiye	5.950.181	TUIK, 2022; Yurdakul et al., 2021b
Average price of a 0-3 month old calf (\$)	577,0 (420-775)	TUIK, 2020
Sickness rate of newborn calves	24,7	Ayvazoğlu Demir et al., 2019
Mean umbilical lesions rate in calf (%)	38,6 (5,0-70,0)	Expert opinion
Cost of operation (\$/per calf)	34,9 (16,39-81,97)	Expert opinion
Cost of treatment and drug (\$/head)	27,9 (10,92-54,64)	Expert opinion
Cost of refomed animal*	144,25 (105,0-193,75)	Expert opinion
Extra care-feeding cost after operation (\$/day/per calf)	1,64 (1,02-3,16)	Calculation
Postoperative recovery time (day)	23,5 (9-40)	Expert opinion

Estimated loss in case of operation in umbilical lesions = number of calves with umbilical lesions x proportion of animals with umbilical lesions x rate of operation x rate of reformation x Refome animal cost + number of calves with umbilical lesions x proportion of animals with umbilical lesions x operation and treatment costs + number of calves with umbilical lesions x proportion of animals with umbilical lesions x success rate of operation x recovery period x extra care fee

Estimated loss in case of no operation in umbilical lesions = number of calves with umbilical lesions x mortality rate x calf price + number of calves with umbilical lesions x reformation rate (1- mortality rate) x calf price (1/4)

71 18,3 TL=1 USD\$ in 2022 year.

72 * ¼ of the calf price is taken into account.

73 Results and Discussion

74 In new-born calves, the umbilical cord closes on average on the 5th day after birth in the absence of
75 any complications (Hides & Hannah 2005; Yurdakul et al., 2021a). However, if the care and feeding conditions
76 of the calf are inadequate, lesions in the umbilical region are inevitable.

77 Umbilical infections, which have an important place in terms of surgical diseases in new-born calves,
78 are one of the most common problems encountered in calves, and in this study, the average rate of umbilical
79 lesions was determined as 38.6% (min: 10, max: 60). In parallel with this finding, it was reported that umbilical
80 lesions were seen between 1.3% and 66.15% in other studies (Cihan et al., 2006; Görgül et al., 1991; Hayat
81 et al., 2019; Pamuk et al., 2009; Demir et al., 2020; Yurdakul et al., 2021b). However, when compared with
82 European countries, it was determined that the rate of umbilical infections was higher in Turkey (Svensson et
83 al., 2003; Cihan et al., 2006; Wieland et al., 2016; Yanmaz et al., 2017). This situation has been interpreted
84 that breeders in Turkey do not pay enough attention to umbilical hygiene in new-born calves. However,
85 Svensson et al. (2003) reported that the umbilical lesion rate can be reduced to 1.5% with postnatal umbilical
86 hygiene and adequate colostrum intake.

87 In this study, the distribution of 683 calves brought with complaints of umbilical lesions between 2007
88 and 2022 is given in Figure 1.

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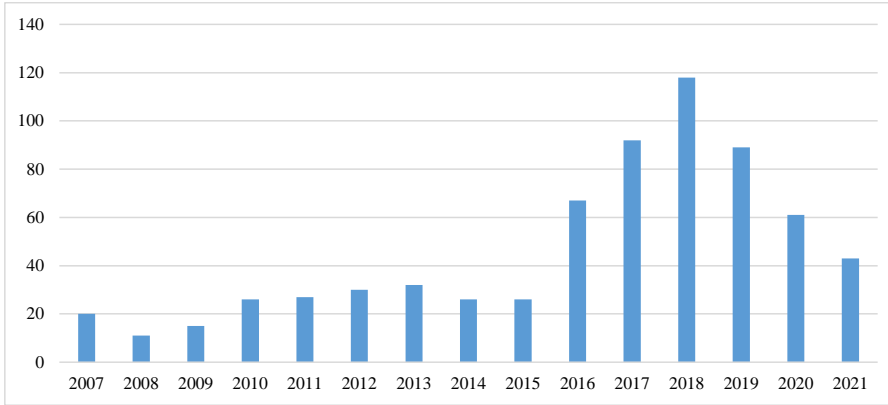


Figure 1 Distribution of umbilical lesions by years

When Figure 1 is examined, it is seen that the number of calves brought to the veterinary clinic with umbilical lesions varied between 20 and 30 between 2007 and 2015, but increased after 2016.

In this study, 46.1% of the 683 calves with umbilical lesions were diagnosed with hernia, 39.8% with omphalitis, 10.4% with abscess and 3.7% with urachus fistula. Table 2 shows the relationship between the sex of the calves and the incidence of umbilical lesions.

Table 2. Occurrence of umbilical lesions by gender

Diagnosis	Gender		Total
	Female	Male	
Omphalitis	78 (28,7%)	194 (71,3%)	272
Hernia	95 (30,2%)	220 (69,8%)	315
Abscess	22 (31,0%)	49 (69,0%)	71
Urachus fistula	19 (76,0%)	6 (24,0%)	25
Total	214 (31,3%)	469 (68,7%)	683

$\chi^2=24,281$ $P=0,000$ $P<0,01$

When Table 2 is examined, in terms of rate, 76% of females and 71.3% of males were diagnosed with urachus fistula and omphalitis, respectively, and it was determined that there was a statistically significant difference between the rates of umbilical lesions and gender ($p<0.01$).

In this study, it was determined that 68.7% of the calves that came to the research hospital for umbilical lesions were male and 31.3% were female and the difference was statistically significant. In other studies conducted in parallel with the results of this study, it was reported that umbilical lesions in new-born calves were more common in males (Belge *et al.*, 1996; Kılıç *et al.*, 2005; Cihan *et al.*, 2006; Sağlıyan *et al.*, 2016; Yurdakul *et al.*, 2021a). The higher incidence of umbilical lesions in males may be explained by the fact that the urethra is physiologically close to the navel in males and the umbilical cord comes into contact with urine. In addition, it was determined that urachus fistula was more common in females with a rate of 76% and omphalitis was more common in males with a rate of 71.3% and the difference was statistically significant ($P<0.01$).

Of the calves that came to the veterinary clinic, 73.2% were simmental, 12.2% were montophone, 9.4% were simmental crossbred and 5.3% were local breeds and the rates of umbilical lesions according to the breeds of the calves are given in Table 3.

When Table 3 is examined, it is seen that simmental and simmental cross calves were diagnosed with hernia at a proportionally higher rate, while omphalitis was diagnosed in local breed calves and abscess was diagnosed in montophone calves. As a matter of fact, the chi-square analysis showed that there was a statistically significant difference between the umbilical lesions seen according to the breeds ($P<0.05$).

Table 3 Ratio of umbilical lesions by calf breeds

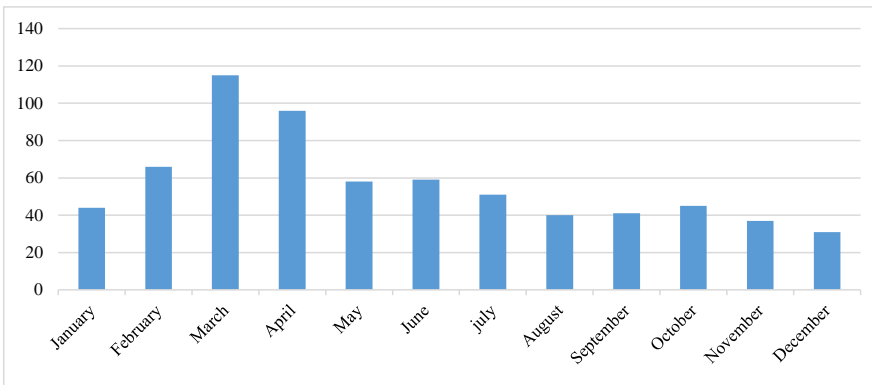
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Breeds	Diagnosis				Total
	Omphalitis	Hernia	Abscess	Urachus fistula	
Simmental	203 (40,6%)	235(47,0%)	43 (8,6%)	19 (3,8%)	500
simmental crossbred	21 (32,8%)	34 (53,1%)	8 (12,5%)	1 (1,6%)	64
montophone	31(37,3%)	31 (37,3%)	18 (21,7%)	3 (3,6%)	83
Local breed	17 (47,2%)	15 (41,7%)	2 (5,6%)	2 (5,6%)	36
Total	272 (39,8%)	315 (46,1%)	71 (10,4%)	25 (3,7%)	683

121 $\chi^2=17,756 P=0,038 P<0,05$

122 In this study, it was determined that 73.2% of umbilical lesions occurred in simmental, 12.2% in
 123 montophone, 9.4% in simmental crossbred and 5.3% in local breed calves. In parallel with the findings of this
 124 study, Yurdakul *et al.*, (2021) and Ayvazoğlu Demir *et al.*, (2019) reported that 50-55% of umbilical lesions
 125 occurred in simmental calves. This situation can be explained by the fact that the presence of simmental
 126 animals in Turkey, especially in recent years, is higher than other breeds and they are more susceptible to
 127 diseases than domestic cattle breeds.

128 In this study, the distribution of umbilical lesions in the months of 2007-2022 in the veterinary clinic is
 129 given in Figure 2.



130 **Figure 2** Distribution of umbilical lesions by months

131 When Figure 2 is examined, it is seen that a significant portion of umbilical lesions occur in March and
 132 April, which is the birth season. In the calculation made, it was determined that 39.4% of the umbilical lesions
 133 came to the veterinary clinic in spring, 20.6% in winter and 22% in summer. In parallel with the findings of this
 134 study, in the interviews with 25 specialist veterinarians, it was stated that the most common complaints of
 135 umbilical lesions were in March and April. The rates of umbilical lesions by seasons are given in Table 4.
 136
 137
 138
 139

Table 4 The rates of umbilical lesions by seasons

Season	Diagnosis				Total
	Omphalitis	Hernia	Abscess	Urachus fistula	
Winter	57 (40,4%)	59 (41,8%)	15 (10,6%)	10 (7,1%)	141
Spring	121 (45,0%)	123 (45,7%)	21 (7,8%)	4 (1,5%)	269
Summer	54 (36,0%)	72 (48,0%)	19 (12,7%)	5 (3,3%)	150
Autumn	40 (32,5%)	61 (49,6%)	16 (13,0%)	6 (4,9%)	123
Total	272 (39,8%)	315 (46,1%)	71 (10,4%)	25 (3,7%)	683

140 $\chi^2=16,961 P=0,049 P<0,05$

141 When Table 4 was examined, it was seen that omphalitis, hernia and abscess came to the clinic more
 142 frequently in spring months, hernia and abscess in autumn and summer months, urachus fistula in winter
 143 months and the difference was statistically significant ($P<0,05$).

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144 In the study, it was determined that 54.8% of the 683 calves that came to the research hospital with
 145 umbilical lesions were younger than 30 days old, 22% were 31-60 days old and 23.3% were older than 60
 146 days old. The age of the calves and the rates of umbilical lesions are given in Table 5.

147 **Table 5** The incidence of umbilical lesions with the age of the calves

Day	Diagnosis				Total
	Omphalitis	Hernia	Abscess	Urachus fistula	
<30 day	180 (48,1%)	150 (40,1%)	26 (7,0%)	18 (4,8%)	374 (100%)
31-60 day	59 (39,3%)	61 (40,7%)	25 (16,7%)	5 (3,3%)	150 (100%)
61-90 day	24 (29,3%)	47 (57,3%)	9 (11,0%)	2 (2,4%)	82 (100%)
>90 day	9 (11,7%)	57 (74,0%)	11 (14,3%)	-	77 (100%)
Total	272 (39,8%)	315 (46,1%)	71 (10,4%)	25 (3,7%)	683 (100%)

148 $\chi^2=58,858 P=0,000 P<0,01$

149 When Table 5 was analyzed, it was seen that omphalitis was more common in calves younger than
 150 30 days (48.1%), hernia was more common in calves older than 90 days (74%), abscess was more common
 151 in calves 30-60 days and older than 90 days and the difference was statistically significant ($P<0,05$).

152 Hernia and omphalitis were mostly diagnosed in calves brought to the research hospital with umbilical
 153 lesions, and this finding is in parallel with the results of Yurdakul *et al.* (2021). However, unlike the finding of
 154 this study, it has been reported that omphalitis and urachus infections are more common among umbilical
 155 lesions (Kılıç *et al.*, 2005; Marchionatti *et al.*, 2016; Moscuzza *et al.*, 2014). It can be said that the reason why
 156 omphalitis is more common is that postnatal umbilical care is not performed sufficiently, calves do not receive
 157 the required amount of colostrum immediately after birth, and it is closely related to the hygiene status of the
 158 shelter (Yurdakul *et al.*, 2021; Ayvazoğlu Demir *et al.*, 2019). As a matter of fact, studies have reported that
 159 ensuring the hygiene of the umbilical region after birth is the most effective disease protection and control
 160 method in preventing infectious lesions of the umbilical region such as omphalitis (Grover & Godden, 2011;
 161 Wieland *et al.*, 2016). In this study, it was determined that postpartum disease prevention and control
 162 expenditures are much cheaper than surgery and the price difference is at least 20 times. In addition,
 163 considering our clinical experience, it has been observed that operative treatment may be dysfunctional in
 164 patients with sepsis and deaths may occur due to comorbidities.

165 In the study, it was determined that 90.2% of the calves that came to the veterinary clinic with the
 166 complaint of umbilical lesion recovered, 0.3% of them did not change their condition, 9.4% had complications
 167 and 0.1% died as a result of the treatment. The relationship between the diagnosis of the disease of the calves
 168 coming to the clinic and the success of the operation is given in Table 6.

170 **Table 6** Success of the operation with the diagnosis of the disease of the calves

Diagnosis	Success of the operation		Total
	Success	Complication	
Omphalitis	245 (90,7%)	25 (9,3%)	270 (100%)
Hernia	287 (91,1%)	28 (8,9%)	315 (100%)
Abscess	62 (88,6%)	8 (11,4%)	70 (100%)
Urachus fistula	22 (88,0%)	3 (12,0%)	25 (100%)
Total	616 (90,6%)	64 (9,4%)	680 (100%)

171 $\chi^2=0,639 P=0,888 P>0,05$

172 When Table 6 is examined, it is seen that while the rate of complications in omphalitis and hernia is
 173 approximately 9%, the rate of complications in abscess and urachus fistula is higher, but in the chi-square
 174 analysis, it was determined that there was no statistically significant difference between the diagnosis of the
 175 disease and the prognosis ($P>0,05$).

176 In the study, it was determined that 9.1% of the calves coming to the veterinary clinic with the complaint
 177 of umbilical lesion showed mild symptoms, 82.3% showed moderate symptoms and 8.6% showed severe
 178 symptoms. The relationship between the prognosis of the disease and the success of the operation in calves
 179 coming to the clinic is given in Table 7.

180
181

182 **Table 7** The success of the operation with the prognosis of the disease of the calves

Prognosis	Success of the operation		Total
	Success	Complication	
Slight	57 (91,9%)	5 (8,1%)	62 (100%)
Middle	505 (90,2%)	55 (9,8%)	560 (100%)
Severe	54 (93,1%)	4 (6,9%)	58 (100%)
Total	616 (90,6%)	64 (9,4%)	680 (100%)

183 $\chi^2=0,673$ $P=0,714$ $P>0,05$

184 When Table 7 is examined, it was determined that 90.6% of the calves were successful after the
 185 operation applied to the calves coming to the clinic and there was no statistically significant difference between
 186 the prognosis of the disease and the success of the operation ($P>0.05$).

187 In the study, the results of the Delphi Survey conducted with expert veterinarians (Expert opinion) to
 188 determine the estimated economic loss caused by umbilical lesions are given in Table 8.

189 **Table 8** Technical parameters of the economic losses due to umbilical lesions in Turkey

Variable	Mean (Min-Max)
Mean umbilical lesions rate in calf (%)	38,6 (10-60)
Live weight loss in calves due to umbilical lesions (%)	16,6 (10-50)
Rate of growth retardation in animals due to umbilical lesions (%)	46,6 (10-90)
Mortality rate of calves in case of untreated disease (%)	67,8 (30-90)
Recovery rate of calves in case of untreated disease (%)	12,5 (5-50)
Probability of operation for calves with umbilical lesions (%)	92,6 (80-98)
Operation success rate in calves (%)	73,6 (50-98)
Postoperative recovery time (Day)	23,5 (9-40)
Probability of return of the calf after the operation (%)	71,6 (50-95)
Recovery time of the calf after the operation (Month)	1,5 (1-2)
Probability of any postoperative complication (%)	28,9 (5-70)
Recurrence rate of the disease within 1 year after treatment (%)	10,7 (0-20)
Rate of reformed calves after navel operation (%)	53,8 (10-70)

191 According to the data obtained, the incidence of umbilical lesions ranged from a minimum of 10% to a
 192 maximum of 60%, with an average of 38.6%. In the interviews with the experts, it was determined that 95.6%
 193 of the calves brought to the veterinary clinics with the complaint of umbilical lesions were operated. The
 194 success rate of the operations performed was 73.9% (50%-98%) and it was stated that the calves recovered
 195 within 23.5 days on average and 71.6% (50%-95%) of the calves recovered within 1.5 months (30-60 days).

196 In the interviews, it was stated that 28.9% of the calves were likely to develop a complication due to
 197 postoperative care and feeding errors and 10.7% of the calves could relapse within 1 year. In the interviews,
 198 it was stated that 53.8% of the calves were reformed after the operation due to both growth retardation and
 199 complications. In the Delphi survey, it was also stated that the recovery rate of calves without operation was
 200 as low as 12.5% and the mortality rate was 67.8% in the absence of operation.

201 **Table 9** Estimated cost of operations performed due to umbilical lesions in Turkey (\$)*

Variable	Loss per calf (\$/calf)	(%)	Estimated average loss	Optimistic scenario	Pessimistic scenario
Reformed animal loss	144,3 (105-195)	58,75	40.768.386,06	5.837.539,19	61.949.395,53
Operation cost	34,9(16,39-81,97)	14,21	18.333.730,73	9.112.120,70	37.201.406,24
Post-operative medication cost	27,9 (10,93-54,65)	11,36	14.656.478,14	6.076.600,32	24.802.450,30
Extra post operative care cost	38,5 (9,18-86,4)	15,68	14.900.983,92	5.001.603,58	19.605.962,54
Total	245,6	100,00	88.659.578,85	26.027.863,80	143.559.214,62

202 * The umbilical lesion rate was calculated as 38.6%.

In line with the data obtained, the estimated cost of operations performed due to umbilical lesions in Turkey is given in Table 9. According to the data obtained, it was calculated that 5.950.181 calves were born in Turkey in 2022 and 567.302 of them had umbilical lesions. When Table 9 is examined, it is seen that the economic loss per calf is 245.6 \$/head on average and the estimated annual loss due to the operation of umbilical lesions in Turkey is 88 million 660 thousand \$, whereas in optimistic and pessimistic cases, this loss was estimated as 19 million 247 thousand and 143 million 559 thousand \$, respectively. The study also calculated that the loss due to umbilical lesions would be \$248 million 282 thousand with a mortality rate of 67.80% and 32.2% loss of reformed animal value.

In this study, it was determined that 53.8% of the animals were disposed of due to complications. Infections that develop as a result of umbilical lesions such as omphalitis, omphalophlebitis, omphaloarteritis, urachus fistula, umbilical abscess and hernia umbilicalis that are not treated effectively can lead to serious complications by hematogenous transport to joints, lungs, kidneys and other organs (Alkan et al., 2019; Marchionatti et al., 2016; Yurdakul et al., 2021b). In particular, due to pyemia caused by umbilical infections, arthritis, septicemia, etc. can be seen in calves, which causes extra cost loss and causes economic losses due to death in untreated and unresponsive patients.

Although there are medical treatment options in the treatment of umbilical lesions, very effective results cannot be obtained. As a matter of fact, in the Delphi survey, it was also stated that the recovery rate was as low as 12.5% in non-operated calves and the mortality rate was 67.8% in non-operated calves. In this context, operation is the most radical treatment option in the treatment of all lesions, especially hernia in umbilical lesions (Ortved, 2017). However, in this study, it was determined that umbilical lesions seen in new-born calves cause significant economic losses due to both developmental retardation and treatment costs. In the study, no literature on the economic loss caused by umbilical lesions was found. Therefore, in the Delphi survey, the losses due to umbilical lesions in Turkey were estimated by expert veterinarians. It was calculated that the average economic loss per calf is \$245.6/head and the estimated annual loss due to the operation of umbilical lesions in Turkey is \$88 million 660 thousand, but if the operation is not performed, the loss due to umbilical lesions will be \$248 million 282 thousand. In this context, it became clear that the operative method should be chosen only for a complete recovery. However, in the study, it was determined that the success rate in operations performed in the research hospital was 90.6%, whereas this rate decreased to 73.9% in operations performed in private clinics. In line with these data, it can be said that the operations performed in the hospital environment are more successful and it would be better to perform surgical intervention in full-fledged centres in order to reduce economic losses due to postoperative complications and developmental retardation.

Conclusions

In conclusion, considering the difficulties in food supply due to pandemics and wars, which still continue to have effects today, the loss of production due to umbilical lesions in Turkey negatively affects both the sector and breeders. As a matter of fact, diagnosis and treatment fees, operation and postoperative care costs, as well as developmental retardation, patient transportation fees, labour loss spent on sick animals and postoperative complications due to umbilical lesions negatively affect both production loss and business profitability of breeders. However, umbilical lesions, except hereditary ones (such as hernia umbilicalis), can be eliminated with simple preventive measures. In this context, raising awareness of patient owners for preventive purposes, bringing the diseased animals to the nearest full-fledged animal health centre for treatment, and not using calves with congenital hernia umbilicalis as breeding stock will significantly reduce the economic losses that may occur due to umbilical lesions and complications in the livestock sector in Turkey.

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Authors' Contributions

PAD (ORCID: 0000-0002-7010-0475) analysis, writing, review and editing; UY (ORCID: 0000-0002-4782-1012) data collection, methodology, writing; EA (ORCID: 0000-0001-8427-5658) methodology and review; UA (ORCID: 0000-0001-5756-4841) data collection, writing; ÖA (ORCID: 0000-0002-4800-6079) writing and editing.

Conflict of Interest Declaration

The authors declare that they have no conflicts of interest relative to the content of this paper.

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Commented [a6]: In the conclusion section, please add the number of losses caused by umbilical lesions in calves, so that the objectives of this study are answered.

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