Acellular fish skin may be used to facilitate wound healing following wide surgical tumor excision in dogs: a prospective case series

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OBJECTIVE
To prospectively evaluate clinical outcomes using acellular fish skin grafts (FSGs) for the management of complete wound healing by secondary intention after wide surgical excision of skin tumors in dogs.

ANIMALS
5 dogs undergoing wide surgical excision of skin tumors on the distal extremity.

CLINICAL PRESENTATION AND PROCEDURES
FSGs were applied to surgical wound beds following wide excision of the tumor. Bandages were changed weekly and additional grafts placed when integration of the previous graft was complete. The wounds were assessed for the following: dimensions, tissue health (color), time to complete epithelialization, complications, and tumor recurrence.

RESULTS
All masses were excised with 2-cm lateral margins and 1 fascial plane deep to the tumor. Tumor diagnoses included 3 mast cell tumors and 2 soft tissue sarcomas. Surgical wounds had a median area of 27.6 cm² (range, 17.6 to 58.7 cm²). The median number of FSG applications was 5 (range, 4 to 9 applications). Complete epithelialization occurred within 7 to 9 weeks for uncomplicated wounds (3 of 5) and 12 to 15 weeks for complicated wounds (2 of 5) that sustained self-trauma. There were no adverse events related to the use of FSGs. Local recurrence was not seen over a follow-up period ranging from 239 to 856 days.

CLINICAL RELEVANCE
Wide surgical excision of distal extremity skin tumors, followed by repeated application of acellular FSGs, resulted in complete healing of all wounds with no adverse events. This treatment method does not require advanced reconstructive surgical skills and may be useful for the management of skin tumors on the distal extremities.
required a free-skin graft to facilitate healing. Additionally, there was a lack of detailed wound descriptions and dressing or bandaging techniques, making it challenging to determine factors that affected time to complete wound closure.

Alternatively, planned marginal excision of the mass followed by primary closure may be performed with the intent to treat the surgical site with adjuvant local therapy postoperatively, such as with radiation or electrochemotherapy. Complications reported include wound dehiscence, self-trauma, osteonecrosis of the underlying bone, and local necrosis. Furthermore, radiation therapy is often not financially feasible or available for many clients. Therefore, marginal excision as a sole treatment for skin tumors is often suboptimal, failing to achieve complete surgical margins. As a result, recurrence rates range from 11% to 80% for low-grade and high-grade sarcomas, respectively. In tumors of the extremities, amputation may be performed to ensure adequate margins are obtained; however, this radical approach is often deemed overly aggressive for smaller or low-grade tumors.

Recently, an acellular fish skin graft (FSG; Kerecis Omega3) has become available for treatment of complicated wounds in humans. Obtained from North Atlantic cod, the graft is rich in omega-3 fatty acids, collagen, fibrin, proteoglycans, and glycosaminoglycans and therefore serves as a good skin substitute. It is an acellular dermal matrix (ADM) that has very similar microscopic properties to the extracellular matrix (ECM) in mammalian skin. There are several other types of ADMs that have been used in both human and veterinary medicine, such as intestinal submucosa, peritoneal membrane, or amniotic tissue derived from porcine and bovine as well as human cadavers. In veterinary medicine, porcine small intestine submucosa meshes are most commonly used to recreate the natural missing ECM. In 2015, Baldursson et al. compared the healing rates of humans with full-thickness wounds that were treated with either fish skin ADMs or porcine small intestine submucosa and found that wounds healed significantly quicker when treated with fish skin ADMs. A study looking at the utilization of FSG for treatment of deep partial-thickness burn wounds in pigs found that FSG treatment resulted in faster induction of granulation tissue, vascularization, and epithelialization in comparison to fetal bovine dermis.

Additional benefits of acellular FSGs include its inability to incite an autoimmune response and transmit communicable diseases to mammalian species. FSG has been shown to accelerate wound healing, is an effective antimicrobial barrier, and can be stored at room temperature with a shelf life of 3 years. The product is subjected to less rigorous tissue processing than other mammalian-derived biomaterials, which must go through “viral inactivation” by use of harsh detergents to remove all soluble components from the tissue. This procedure eliminates lipids, glycoproteins, glycans, elastins, hyaluronic acid, and soluble collagen, as well as other essential biological components. Structure and bioactive composition can be preserved through mild processing, along with antiviral, antibacterial, and anti-inflammatory properties.

Utilization of the FSG for wound management in companion animals has been retrospectively documented with resultant complete wound healing of most wounds and no attributed adverse events. Similarly, there has been a case report describing the successful use of tilapia skin graft for management of a large bite wound in a dog resulting in complete epithelialization. Prospective analysis of wound healing outcomes in companion animals following use of the acellular FSG has not been reported. Additionally, use of the acellular FSG over oncological wound beds has not been reported in either the veterinary or human literature.

The objective of this study was to prospectively evaluate the outcomes of dogs presenting for tumors of the distal extremities, managed with acellular FSGs following wide surgical excision of the tumor. It was hypothesized that placement of the acellular FSG following wide surgical excision of locally invasive tumors in dogs would be well tolerated, promote complete wound healing as compared to results from the literature, and be an acceptable treatment option for oncological wound closure.

Materials and Methods

Animals
From August 2020 to May 2022, client-owned dogs undergoing surgical excision of distal extremity tumors were enrolled prospectively. Cases were included if they had a locally invasive mass or tumor scar distal to the elbow or stifle, diagnosed preoperatively with cytology or histopathology, and were undergoing wide surgical excision (defined as 2- to 3-cm lateral margins and 1 fascial plane deep to the tumor and/or scar). Dogs were excluded if blood work was compatible with an endocrinopathy, they were receiving steroid treatment, or they received neoadjuvant chemotherapy or radiotherapy. This study was approved by the IACUC of the University of Florida (IACUC No. 202011079). All options available at our institution for the management of distal extremity tumors were discussed with pet owners, and owner consent was obtained.

Anesthesia and surgery
All dogs were anesthetized according to a protocol created by the board-certified anesthesiologist. Perioperative antimicrobial prophylaxis (cefazolin sodium, 22 mg/kg, IV) was administered to all dogs 30 minutes prior to initiation of surgery and every 90 minutes intraoperatively. General anesthesia was maintained with isoflurane in oxygen. All surgical procedures were performed by a board-certified veterinary surgeon specialized in surgical oncology. A sterile ruler and marker were used to measure and mark 2-cm-wide margins around the mass prior to excision. All masses were excised with 2 cm of lateral margins and 1 fascial plane deep to the tumor. Fascia was secured to the skin using intermittent interrupted sutures to maintain orientation of tissues. Ink was applied to surgical margins of resected tissue, and samples were placed in neutral-buffered 10% formalin prior to histopathological analysis. Dogs undergoing MCT excision also had the sentinel lymph node removed.
Graft application

The acellular FSG was placed following wide surgical excision of the tumor. Bandages were changed once weekly with additional FSGs placed over the wound bed once the previous graft was fully integrated. At each bandage change, wounds were gently lavaged with sterile saline (0.9% NaCl) and, prior to the placement of a new FSG, sharp debridement was performed to remove any excessive granulation tissue and initiate bleeding within the wound bed. Following debridement, the FSG was aseptically removed from the packaging, cut to fit the wound size, and rehydrated for 1 minute by placing it in a bowl of room-temperature sterile saline. The FSG was applied directly to the wound bed (scale pattern side up) and fixed in place with skin sutures or staples. The graft was covered with a nonadherent dressing (Adaptic; Systagenix) and bolstered with a secondary dressing ideal for optimal exudate management: calcium alginate during the initial wound healing stages and hydrophilic foam dressing (silicone foam dressing; JorVet) in the later stages. The dressings also functioned to ensure graft contact with the wound bed. A soft padded bandage was placed to maintain and protect dressing placement. All bandage changes were performed by a clinician. Sedation was used to facilitate bandage changes whenever a new FSG was applied and was accomplished using dexmedetomidine (3 to 6 µg/kg, IV) and/or butorphanol (0.1 to 0.2 mg/kg, IV) and reversed with atipamezole volume IM equal to the administered volume of dexmedetomidine.

Dogs were discharged on oral carprofen (2.2 mg/kg) or meloxicam (0.1 mg/kg) and gabapentin (10 mg/kg) for a minimum of 7 days and used as needed throughout the course of the treatment period. Trazodone (3 to 6 mg/kg, PO) was used as needed to aid in postoperative activity restrictions.

Wound assessment and data collected

Information regarding signalment (ie, breed, sex, age, and body weight), tumor type, surgical margins obtained, histologic margins reported, and tumor recurrence for each dog was recorded.

A validated mobile platform–based 3-D wound management device (Insight; eKare Inc) was used for obtaining and tracking wound dimensions and identifying color of the tissues present in the wound bed. After placing a reference marker with a diameter of 1.90 cm, a scaled high-resolution 2-D photo with an iPhone XR native 12-megapixel camera was used to obtain images of the wound at each assessment/bandage change. Using the associated mobile application, the device was used to obtain length, width, depth, and area measurements for each wound. An outline of the wound border, semiautomatically defined by the user, was used to define the region of interest. The application’s Color Classification feature was utilized to break down wound areas into 3 different categories on the basis of color analysis and machine learning methods. The color of the wound bed was categorized as healing (red), devitalized (yellow), and dead (black). Quality control was performed on all wound images following each bandage change to ensure accurate measurements and wound bed categorization. Additionally, the wounds were assessed for time to complete wound healing (defined as days from the date of surgery to complete epithelialization of the wound), percentage decrease of wound bed size at each visit, subjective assessment of cosmetic outcome by the overseeing clinician, and complications during the healing process.

Statistical analysis

For descriptive analysis, categorical data was tabulated using an electronic spreadsheet (Sheets; Google LLC). Additionally, numbers, medians, ranges, and means were calculated using an online calculator (Mean, Median and Mode Calculator; CalculatorSoup LLC).

Results

Animals

Five dogs (3 castrated males and 2 spayed females) with distal extremity tumors undergoing wide surgical excision were enrolled in the study. Three of the 5 dogs were identified as mixed-breed dogs, and other breeds represented included an Alaskan Klee Kai and a Doberman Pinscher. Dogs had a median weight of 27.4 kg (range, 8.8 to 46.1 kg). The median age was 8 years old (range, 7 to 11 years old).

Surgical resection and histologic evaluation

All masses were located over the distal limbs, including 4 right antebrachial masses and 1 left metatarsal mass. Before enrolling in this study, dog 5 had already undergone 2 incomplete excisions of an STS. In this dog, 2-cm lateral and 1 fascial plane–deep margins were obtained in relation to the scar and recurrent mass.

Two dogs were diagnosed with a dermal mast cell tumor (MCT), both classified as Patnaik grade 2, Kiupel low grade. One dog was diagnosed with a subcutaneous MCT, and 2 dogs were diagnosed with a grade 1, low-grade STS. Results of histological assessment of tumor specimens indicated that 3 of the 5 tumors had incomplete histological margins and 2 of the 5 were described as having clean margins (Table 1).

Graft application and wound assessments

Four out of 5 dogs had an FSG placed immediately after mass excision during the same anesthetic event. One dog underwent a reconstructive procedure for a wide excision of a dermal MCT on the right antebrachium. This dog initially had the surgical site closed primarily with a full-thickness skin graft and was discharged after 4 days of hospitalization following vacuum-assisted closure. At the 1-week postoperative bandage change, the skin graft was no longer viable and removed. Two days later, an FSG was placed on an otherwise healthy wound bed.

The median tumor volume was 1.37 cm$^3$ (range, 0.35 to 3.75 cm$^3$). The initial surgical wound sites had a median surface area of 27.6 cm$^2$ (range, 17.6 to 58.7 cm$^2$). The median number of FSG applications was 3 (range, 2 to 5 graft applications). The median number of bandage changes was 11 (range, 9 to 23 bandage changes). The median time between each FSG application was 8 days (range, 5 to 18 days). Complete epithelialization occurred in all surgical wounds. In dogs
1, 3, and 5, wounds healed without complication in 65, 52, and 64 days, respectively, after the first FSG was placed. Dog 2 had the longest time to complete wound healing (105 days) due to complications related to self-trauma and repeated consumption of the bandage material. Dog 4 healed in 84 days and sustained several minor setbacks in wound healing after the soft padded bandage had slipped down over the wound, traumatizing the re-epithelialized tissue, along with self-trauma to the wound bed (Figure 1).

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<table>
<thead>
<tr>
<th>Case</th>
<th>Signalment</th>
<th>Location of wound</th>
<th>Tumor type</th>
<th>Surgical margin (lateral cm X fascial plane deep)</th>
<th>Histological margin status</th>
<th>Area of initial wound (cm²)</th>
<th>No. of total FSG applications</th>
<th>Days to complete closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7yo MN MBD</td>
<td>Right cranial antebrachium</td>
<td>Dermal MCT Grade 2, low grade</td>
<td>2.0 X 1 X 0.5</td>
<td>Incomplete lateral</td>
<td>27.8</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>8yo MN MBD</td>
<td>Left dorsal metatarsal</td>
<td>Dermal MCT Grade 2, low grade</td>
<td>1.0 X 1 X 0.7</td>
<td>Complete</td>
<td>17.7</td>
<td>4</td>
<td>105</td>
</tr>
<tr>
<td>3</td>
<td>11yo FS Alaskan Klee Kai</td>
<td>Right cranial antebrachium</td>
<td>SC MCT</td>
<td>1.5 X 2.0 X 1.0</td>
<td>Incomplete lateral</td>
<td>17.6</td>
<td>5</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>8yo FS MBD</td>
<td>Right lateral antebrachium</td>
<td>STS Grade 1, low grade</td>
<td>2.0 X 2.5 X 1.5</td>
<td>Complete</td>
<td>27.6</td>
<td>5</td>
<td>84</td>
</tr>
<tr>
<td>5</td>
<td>7yo MN Doberman Pinscher</td>
<td>Right caudal antebrachium</td>
<td>STS Grade 1, low grade</td>
<td>2.0 X 1.5 X 0.5 with a 10-cm scar</td>
<td>Incomplete deep</td>
<td>58.7</td>
<td>9</td>
<td>64</td>
</tr>
</tbody>
</table>

FS = Female spayed. MBD = Mixed-breed dog. MCT = Mast cell tumor. MN = Male neutered. STS = Soft tissue sarcoma. yo = Years old.
A decrease in wound area was most dramatic between the second and fourth weeks after surgery, with an average decrease of 29% ± 7%, and then between the sixth and eighth weeks postoperatively, with an average decrease of 70% ± 11.1% (Figure 2). No wounds developed any clinical evidence of a surgical site infection throughout the trial. The percentage of healing (red), devitalized (yellow), and dead (black) tissue comprising the wound bed was measured at each bandage change. Wound beds on average had 98.3% ± 0.8%, 1.4% ± 0.5%, and 0.2% ± 0.3% evidence of healing, devitalized, and dead tissue, respectively, over the course of treatment. Subjectively there was minimal contraction of the wounds initially, which increased within the sixth to eighth weeks postoperatively. A small area of alopecia was present at the surgical site in all dogs.

**Complications**

There were no adverse events directly related to the use of FSGs. Bandage-related complications were mild and included swelling of the digits or interdigital dermatitis, intermittent lameness, bandage slippage, and premature removal of the bandage. Dog 1 was placed on a 14-day course of oral amoxicillin-clavulanic acid (Clavamox), 15 mg/kg, secondary to a suspected surgical site infection at the superficial cervical lymph node extirpation site (erythema, heat, and swelling noted). Due to lack of owner compliance, dog 2 was presented several times through the emergency service, outside of scheduled bandage changes, due to chewing off the bandage and self-trauma to the wound bed. As a result, additional dermatitis, intermittent lameness, bandage slippage, and swelling noted). Due to lack of owner compliance, dog 2 was presented several times through the emergency service, outside of scheduled bandage changes, due to chewing off the bandage and self-trauma to the wound bed. As a result, additional primary dressings were used, including honey alginate and a bioreorbable polymer matrix (Microlyte; Imbed Bio). Dog 2 was also placed on a 14-day course of oral amoxicillin-clavulanic acid, 15 mg/kg, following self-trauma to the wound bed; however, no culture was obtained. Dog 4 self-traumatized the wound bed following almost complete epithelialization, resulting in prolonged wound care of an additional 2 weeks. Dog 5 reportedly retraumatized the new skin several weeks after the conclusion of the study that was managed by the owner and eventually healed. During this second period of bandaging, the dog was reported to have ingested bandage material, requiring endoscopy for removal. There were no contracture complications noted of any of the wounds.

**Discussion**

For dogs in the present study, wide surgical excision of locally aggressive tumors of the distal extremities, managed with repeated applications of an acellular FSG, resulted in complete wound healing. The wound bed remained consistently healthy throughout the study. There were no apparent direct complications related to the use of the FSG, but epithelialized skin was thin and prone to injury. No local recurrence was noted for any cases within the follow-up time period.

The acellular FSG product used in this study has been FDA approved for use in humans for partial- and full-thickness wounds secondary to trauma or surgery, draining wounds, soft tissue reinforcement, and various types of ulcers (eg, pressure, venous, diabetes, etc)28,39. The 3-D microporous structure of the FSG enables the harmonious colonization of autologous cells, such as fibroblasts, to infiltrate the area and promote angiogenesis.40 The xenograft, which transitions into living tissue, slowly becomes incorporated in the wound bed as the new granulation tissue develops. FSGs were applied to the wound between 5 and 18 days, suggesting complete integration within this time frame. This is similar to the length of time documented for FSG wound integration in human medicine, between 7 and 10 days.36

A noticeable reduction in wound size was first appreciated within the first 2 to 4 weeks of healing. This is comparable with the time frame of a study21 that compared the rate of wound closures using FSG on deep partial-thickness burn wounds in pigs. Wound contraction begins once there is a significant amount of myofibroblasts within the ECM. As healing progresses, the number of fibroblasts typically decrease in the wound, correlating to a decrease in contractility.41 When wound contraction stops prior to full wound coverage, the remaining granulation bed must be covered solely by the processes of re-epithelialization. FSGs have been shown to speed the rate of re-epithelialization without an increase in contraction, when compared to wounds covered with a fetal bovine ADM or wound healing by second intention alone.31 The authors suspect that by continuously reapplying FSGs and thus supplying beneficial qualities to the granulation bed, the wound is able to maintain an accelerated rate of epithelialization. The rate of epithelialization in a large dog bite wound treated with tilapia fish skin graft was calculated to be 1.76 mm/d, accelerated compared to 1 mm/d (normal rate of re-epithelialization).32 This theory may be able to explain how the wounds in this study continued to decrease in size by a greater degree between the sixth to eighth week of healing, compared to earlier time points in the study.

Complete epithelialization occurred within 7 to 9 weeks for the 3 uncomplicated wounds and 12 to 15 weeks for the remaining 2 complicated wounds that sustained self-trauma. These findings demonstrate a
similar to slightly shorter time to healing as a retrospective study of 31 dogs comparing the rates of second-intention healing after wide resections of STS on distal limbs, in which 77% of wounds healed by 12 weeks. The final length of time to heal for the remaining 23% was not disclosed. The prolonged healing exhibited from dogs 2 and 4 was a result of wound complications secondary to self-trauma. The wounds in this study ranged from 17.6 to 58.7 cm². It is generally expected that larger wounds typically take a longer time to heal completely. However, despite dog 5 having the largest wound following STS scar revision and mass removal, complete epithelialization occurred within 7 weeks. The previously mentioned study evaluating second-intention healing for STSs reported wounds that ranged in size from 18.84 to 113.10 cm² and found that there was no significant relationship between surface area of wounds and their time to healing.

For evaluation of the health of the granulation bed, percentage of tissue color was measured. All wounds maintained a healthy bed of granulation tissue (red) throughout the course of treatment. Objective tissue color measurements can help guide clinical decision-making. While not appreciated during this study, devitalized or necrotic tissue could be debried to expose a layer of vascular tissue, and repeated debridements followed by applications of FSG to the wound would likely promote greater 3-D cell ingrowth and tissue regeneration.

Postoperative complication rates following various reconstructive techniques have been reported to be between 50% and 70% and include skin graft or flap failure, surgical site dehiscence and infections, seroma formations, and bandage-induced complications. Additionally, the need for secondary surgical procedures following complications with healing secondary to both reconstructive surgery and wound beds unable to heal by second intention alone has been reported. None of the dogs in the current study required any additional surgical procedures to facilitate complete healing by second intention with the use of the FSG.

Second-intention healing has been linked to a short-term complication rate of 22.6% due to bandage complications and surgical site infection. Bandage complications reported include mild erythema, swelling, and pain to more severe consequences such as ischemic injury. The bandage-related injuries experienced in this study were mild and similar to what has been previously reported. The most common injuries seen in this study were swollen digits, which resolved with application of a new soft padded bandage. Prolonged wound healing exhibited in 2 dogs was a result of self-trauma to the wound. These findings emphasized the need for proper bandage placement and client education in bandage care. While leaving a wound to heal by secondary intention risks the development of resistant infection, none of the cases in the current study showed any evidence of developing an infection. The use of FSG in large wounds has proven to accelerate epithelialization and therefore can limit exposure for potential infection and associated morbidity to occur. The omega-3 fatty acids within the FSGs have antibacterial properties against multiresistant bacteria and play a key role in the graft’s ability to act as a physical barrier.

It has been demonstrated that FSG can withstand bacteria invasion for up to 72 hours. While 2 dogs received antibiotics during the course of the study, dog 1 received antibiotics for a suspected unrelated infection distant to the surgery site and dog 2 received antibiotics prophylactically from an emergency service without a culture obtained from the wound bed or evidence of an active infection.

In a study of long-term complications from second-intention healing following wide STS excision of the distal limb was seen in 25.8% of dogs. The most common long-term complication in this study was intermittent disruption of the epidermis due to trauma. Similarly in this study, several dogs traumatized the thin layer of epithelial tissue over the wound bed. Healing by second intention relies on maturation and reorganization of the thin layer of epithelial cells to regain, at most, 80% of normal tissue strength, and this process can take 30 days to 1 year. The other complication experienced in that study was decreased range of motion over a joint secondary to wound contracture. Because the inelastic scar tissue formed from second-intention healing inhibits joint extension, significant wounds over a joint’s flexor surface may result in contracture and then subsequent pain and lameness. Although none of the dogs in this study had a wound directly over a joint, applying FSG may be protective against contracture complications experienced with second-intention healing. A review in human literature references several studies that prove ADM applied in wounds over a joint, or wounds with exposed tendon, result in minimal scar contracture and normal range of motion. Second-intention healing faces the challenge of lack of skin and the combative forces between tension on the wound edges and the contraction forces of myofibroblasts, which often result in incomplete wound healing. None of the dogs treated with FSG experienced incomplete wound healing.

Wide surgical excisions are performed with the intention of obtaining histologically clean margins to prevent tumor recurrence. Despite taking 2-cm lateral and 1 fascial plane–deep margins, complete surgical excision was only accomplished in 2 of the 5 dogs within this study. There has been no evidence of local tumor recurrence noted on long-term follow-up. Other studies, utilizing reconstructive techniques for closure of wide tumor excision on the limbs of animals, have achieved clean margins in 66% and 58% of cases. Factors that can increase the risk for incomplete excision of MCT and STS include decreased body weight and increased tumor size. Tumors located on the distal limb compared to those on the head or neck have also been shown to influence the ability of obtaining clean surgical margins of STS. Several studies have found that incomplete excision of MCT is not related to location, which is contradicted by others that have found MCTs in the hind limbs to be positively correlated with inadequate margins. The lack of tumor recurrence could be due to the low histologic grade of the tumors or discrepancies that occur from sample processing resulting in inaccurate histologic margin measurements.

The beneficial characteristics of FSGs, such as anti-inflammatory properties, have been studied fairly well in human medicine and are linked to the omega-3
polyunsaturated fatty acids. Oral supplementation of omega-3 polyunsaturated fatty acids has been used in both human and veterinary medicine as an antineoplasia nutraceutical; however, most of the beneficial inhibitory properties are linked to the immunomodulatory and anti-inflammatory effects. Additional research is required to determine whether the application of FSGs has any antineoplastic properties.

The main limitations of the present case series were the small sample size and lack of control group, making it challenging to analyze the effects of wound size, number of FSG applications, individual variances in healing, and time between FSG applications on wound healing. Dog 1 in the study had the first FSG applied 1 week after initial mass removal and subsequent failure of a skin graft. This wound bed may have received different initial stimulation in comparison to the naive wound beds. Additionally, an artificial intelligence software (InSight; eKare Inc) was used to document wound healing progression of each case and tissue health. Occasionally, wounds were noted to increase in size from prior measurements. This could be secondary to the quality of the image, lighting, positioning of the limb, and positioning of the reference marker. For the most accurate results, the wound needs to be captured straight on and a reference marker placed in the same plane as the wound to calibrate the image. To improve consistency, subsequent photography of the wounds, the previous assessment image is ghosted on the screen to assist the user in capturing the wound from the same perspective. This minimizes positioning error. The version of the device used in this study could not yet accommodate the curved or partially circumferential aspect to limb wounds, making accurate measurement challenging. However, the current updated version can calculate accurate surface area of circumferential wounds. The software also had limitations on evaluation of tissue health. Areas of light refraction were often designated as black and variability in the canine skin margin would yield colors of yellow, incorrectly categorizing these regions as necrotic and devitalized tissue, respectively. Images were always evaluated for quality control and manually adjusted as needed to correct for these discrepancies. Despite these minor limitations, the software was easy to use and documented progression of canine wound healing quite effectively. While sedation was used to facilitate reapplication of FSGs, it was typically unnecessary in the later stages of wound healing. Furthermore, sedation is commonly incorporated into wound care to improve patient comfort and minimize restraint required during dressing changes.

The use of acellular FSGs in dogs for the management of second-intention wound healing following wide surgical excision for locally invasive tumors is well tolerated and resulted in complete wound healing in all cases. The application of acellular FSGs was not attributable to any adverse effects. Acellular FSG is an affordable and shelf-stable product that does not require specialty training and can be easily utilized by both general and specialty practices in wound therapy management. Wide surgical excision of locally aggressive tumors closed via second-intention healing promoted with FSG applications may have some advantages over second-intention healing alone. A larger study that compares both groups is warranted.

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References


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