Bandages, splints, slings and casts are commonly used in veterinary medicine. Proper
application, maintenance, and protection of these devices are necessary to prevent
complications and achieve good outcome. The purpose of this presentation is to refresh
basic knowledge in bandaging techniques and to provide suggestions that may be helpful
to veterinarians and veterinary technicians during bandaging.

The provided information is obtained from personal experience, the veterinary literature,
and from colleagues who were happy to share their tips and tricks with the author over
the last 23 years by multiple veterinary surgeons, some of which with up to 50 years of
experience in this field. Additional and more detailed information on bandaging may be
found in the references at the end of this text.

Prepare all necessary equipment prior to application of a bandage and prior to sedation
of the patient! Bandages consist of multiple layers. To prevent slipping of the bandage
material, non-elastic medical white tape stirrups are placed first on lateral and medial
aspect of the skin at the distal aspect of the foot. They extend the end of the foot by
approximately 1-4 inches, depending on patient size. Placement of a wooden tongue
depressor between the adhesive surfaces of the tapes will allow these to be pulled apart
easily at a later stage, and prevent twisting around their axis. The first layer of the
bandage contacts the wound or skin. When applying a bandage after a standard surgical
procedure with primary closure of the skin, a Telfa-Pad\textsuperscript{a)} can be placed over the skin
incision site first. The next layer consists of cast padding\textsuperscript{b)}, followed by roll gauze\textsuperscript{c)}. At
this stage, the tape stirrups are twisted around their own axis at the distal end of the
bandage, and applied with the adhesive surface to the roll gauze. An outer, protecting,
layer is finally applied. Vetrap\textsuperscript{d)} is most commonly used. If a bandage needs to be kept on
for an extended period of time, or if one is worried that the bandage may slide,
Elastikon\textsuperscript{e)} can be considered. This material seems to be more resistant and slips less
often. The last layer can be decorated, which usually makes for a smile on the owner’s
face, and allows the person who applies the bandage to express his/her skills as an artist
\(\text{😊} \) ! E-collars should be applied to protect the bandage. No-Chew-Vetrap\textsuperscript{b)} or application
of “Bitter Apple” may prevent bandage destruction by the patient.

Implication of splint material in the bandage is occasionally necessary to provide
additional support. In an emergency situation, and when an appropriate amount of
padding has been applied, a newspaper that is rolled together or a stick/piece of wood can
be used. Commercially available support materials are aluminum rods\textsuperscript{f)}, metal splints
(Meta-Mason-Splints\textsuperscript{g)}), and plastic splints. Some of these splints include a small cushion
of foam padding (spoon splints\textsuperscript{h)}), some are formed anatomically to fit the conformation
of thoracic or pelvic limb and are occasionally even designed for the right or left side
(Quick Splints\textsuperscript{i)}). In small patients a wooden tongue depressor, taped to the roll gauze,
may be sufficient. It is cut to the appropriate length and applied to the palmar aspect of the bandage. An example is when additional stability after internal fixation of a radius/ulna fracture is required.

My personal preference in larger dogs that require additional stability or external coaptation is the use of a fiberglass cast\textsuperscript{4}. There are many advantages associated with fiberglass casts. It is light weight, very resistant, and waterproof. It can be cleaned easily and re-applied. The cast material can be conformed to the individual anatomic configuration and length of the animal’s leg. Adjustments can be made such as cutting an opening over the the olecranon, accessory bone, calcaneous, or removing parts of the cast at the cranial aspect of the elbow joint, or caudal aspect of the stifle during cast application or at the time of cast changes. These adjustments reduce the risk for development of pressure sores or decrease skin impingement during ambulation without decreasing the stability of the construct. If cast changes are planned, a bi-valved cast has to be created. Cast cutters are necessary. They can be expensive if purchased from manufactures of orthopedic instruments\textsuperscript{5} but are available at reasonable costs when obtained from other sources\textsuperscript{6}. The oscillating saw prevents damage to padding material or skin.

First, tape stirrups, cast padding and roll gauze are applied as described above. Then a wrap of polyethylene film (such as used for food storage) is wrapped around the roll gauze. This prevents formation of severe adhesions between fiberglass and roll gauze during the first application of a bi-valved cast. Gloves are worn during fiberglass application because the material sticks uncomfortably to the fingers of the person who applies the cast. The fiberglass roll is soaked in water for a few seconds, then applied in turns to the thickness required. 3-5 mm thickness is recommended. The leg should not be moved until the cast is dry (usually 3-5min). Holding on to the cast material during the drying episode should be avoided because this can lead to indentations in the cast material. These could later become a cause for formation of pressure sores. The cast is cut along the sides and the polyethylene wrap or other temporary layer removed. Tape stirrups are now twisted at the base and applied over the roll gauze. Larger size stirrups are now placed onto the roll gauze, the fiberglass valves replaced, and the stirrups taped over the outside of the cast. Additional tape is used to secure the cast. To protect the bottom of the cast, I usually cut small holes into a large piece of Elastikon. The toe-nails of the 3\textsuperscript{rd} and 4\textsuperscript{th} toes extend through this hole. The borders of the Elastikon are folded up. Finally, the outer layer is applied. When a bandage/cast is applied prior to recovery from anesthesia, it is recommended to express the urinary bladder and to apply a waterproof layer, such as an absorbent pee pad to protect the material from urine during recovery. These protective layers have to be removed as soon as the animal is awake to prevent condensation and moisture collection inside the bandage.

A Robert-Jones-Bandage is usually used to stabilize fractures below the elbow or stifle joint on an emergency basis. It consists of a large amount of cast padding (up to one or more inches thick), followed by roll gauze and Vetrap.

A modified Robert-Jones-Bandage is usually applied as support after orthopedic surgery below the elbow or stifle joint. Its main function is reduction of post-operative swelling and prevention of unlimited leg use after surgery. It consists of a few layers of cast padding, followed by roll gauze and an outer layer.
A Spica-Splint is used to stabilize fractures or support orthopedic repairs of and above the elbow joint. They are also used after treatment of lateral elbow luxations, to protect shoulder injuries or scapula damage. These splints are applied in two stages. Stage one is placement of stirrups, cast padding and roll gauze as described above for a modified Robert-Jones-Bandage, reaching from the toes to as proximal as possible. Stage two is wrapping of thorax and connection of limb and thoracic bandages. An adequate amount of cast padding is wrapped around the thorax and neck of the dog. One or two assistants have to lift the patient up. It may help to place the caudal aspect of the animal’s body on one table, the neck and head are supported by a second table and an assistant. The next layer, roll gauze, is applied loosely. This prevents tension around the thorax, which could impair the patient’s ability to breath. If necessary, an additional layer of cast padding may be applied to the lateral aspect of antebrachium and chest, to provide a smooth surface for the following layer, fiberglass. Once hardened, the fiberglass is secured with non-elastic white medical tape to the underlying layers. Then the last layer is applied. Unwrapping and re-rolling of Vetrap may result in less tension in the roll. This may reduce the risk of application of a too tight bandage. To assess the tension of the bandage after application, a scalpel blade should be used to cut small holes in the Vetrap. With too much tension, these holes will “gap open” significantly. If this should be the case, re-wrapping the last layer is recommended to prevent development of respiratory problems. Animals may die from bandages applied too tightly around the thorax.

Velpeau-Slings are used after treatment for medial shoulder luxations, medial shoulder ligament injuries, or scapular injuries. They can also be used to prevent weight bearing of the thoracic limb. Cast wrapping is applied in lateral-to-medial direction around the metacarpus. Then the thorax is included into the wrapping, while shoulder, elbow and carpus are kept in a flexed position. The bandage material is kept caudal to the axilla on the opposite side. Roll gauze and Vetrap are applied in similar manner. As with the spica splint, wrapping around the thorax should be performed loosely to prevent respiratory problems from developing. Velpeau-Slings carry the risk of pressure-sore-development or chronic carpal flexion stiffness. To prevent these complications, sling removal once weekly is recommended. The skin is inspected and the carpus is stretched and massaged.

Carpal-Flexion-Bandages are used to prevent weight bearing on the thoracic limb. These bandages are used occasionally after certain orthopedic surgeries or following repair of flexor tendons or surgery on the foot pads. These bandages consists of only a small amount of non-elastic medical white tape that is applied in a circular fashion around the distal aspect of the antebrachium and metacarpus. Another stirrup is placed around the middle area of the encircling tape. This prevents slipping of tape over the carpus. If necessary, one can include the typical layers of a bandage and a specifically designed aluminum rod or fiberglass support.

Walking bars are used when weight bearing is necessary, but high impact stress on the distal aspect of the limb is not allowed. Examples are after surgery of the metacarpal bones or digits, or to prevent or protect sores on the animal’s pads. A metal rod is bent into a U-shape and taped to the distal aspect of the bandaged foot. If necessary, these protective braces can be included into an external fixator configuration.

Ehmer-Slings are used to prevent weight bearing after injuries of the pelvis, hip, or occasionally after repair of femur fractures in young animals to prevent quadriceps contracture. A common problem with application of these slings is premature slippage.
This may be prevented by using only a small amount of padding material, using Elastikon and including the abdomen of the animal into the sling. A belly-wrap is applied first. The hip, stifle, and tarsus are flexed to the desired degree. The bandage material of choice is placed from medial to lateral around the metatarsus. It is then carried medial to the stifle, placed over the cranial aspect of the thigh, twisted and placed around the medial aspect of the metacarpus. This is repeated several times. Then the tape is applied over the back of the dog and the belly-wrap is included into the sling. In male dogs, I recommend application of a “pee-protection-shield” onto the ventral aspect of the bandage. Iodine impregnated adhesive drape or other water proof adhesive sheets works very well for this purpose. In most cases, the duration of Ehmer-sling application is 10-14 days. Owners should be warned that skin irritations will likely develop. Similarly, swelling of the toes or sores at the calcaneous are frequently observed complications.

**Robinson Off-Weight-Bearing-Slings** allow passive motion of hip and stifle joints while preventing weight bearing. This sling is easier applied and better tolerated than the Ehmer-Sling. A belly-wrap using adhesive tape is applied first. Two-inch white tape is folded at midpoint and the adhesive sides placed against each other. This stirrup is placed around the metatarsus. Adhesive tape is then applied around the two strands at the dorsal aspect of the metatarsus, resulting in a sling around the metatarsus. Both ends of the stirrups are secured by adhesive tape to the belly-wrap. The medial strand of the stirrup is placed on the medial aspect of the slightly flexed stifle joint; the lateral strand of the stirrup is placed on the lateral aspect of the stifle. The stirrups are secured just below the stifle joint by application of adhesive tape that is placed circumferentially around the leg.

**Schroeder-Thomas-Splints**, described to protect injuries of the hindleg, consist of a circular metal rod that is placed around the hip joint and is connected with a U-shaped bar that reaches around the distal aspect of the foot. The application of this splint is not recommended if one is not versed in its application. Considerable artistry is required to properly use this splint. Too many severe complications have been described using this outdated technique that its application is contra-indicated in my opinion.

**Protection of the cast/bandage** is achieved by placing stable and sturdy plastic bags (old IV-fluid bags work well) or specific cast protection covers over the cast/bandage when the animal is taken outside. These have to be removed when the animal is taken back inside to prevent condensation and accumulation of moisture in the bandage material. An E-collar should be worn to protect the bandage from the patient. Exercise has to be limited to the minimal necessary amount to prevent development of rub-sores. Sedatives may be necessary in specific patients. Clients have to be educated about proper bandage care and encouraged to contact the veterinarian if there should be any questions or concerns.

**Bandage changes** are performed on a regular basis and, of course, if there should be any concerns or problems. The frequency of bandage changes depends on multiple factors and is tailored to the individual client and patient. The toes have to be monitored twice daily for signs of spreading apart, and the interdigital space should palpate dry and warm. If the toes spread apart, there is usually swelling of the limb, secondary to a complication. The frequency of bandage changes when treating open wounds depends on the amount of exudation from the wound. Usually, bandage changes are performed once to twice daily initially, or when “strike-through” (seepage of wound exudation fluid to the outer layer of the bandage) is observed. When the outer bandage layer becomes wet, bacteria travel
easily towards the inside and can colonize wounds. The frequency of bandage changes can be reduced over time. Once a healthy granulation bed has formed and the amount of exudation has decreased significantly, wounds can heal over time without a bandage.

Bandages used to support a primary internal orthopedic fixation of a fracture or an arthrodesis are evaluated every week or two, depending on each case. It is my experience that performing bandage changes every two weeks significantly reduces the risk development of pressure sores or interdigital dermatitis. When performing bandage changes the non-elastic white adhesive medical tape is cut it at the distal end of the foot. This prevents recurring irritation from ripping hair out of the skin. New tape is applied over the previous one when a new bandage is applied.

If severe limb swelling is noted at the time of first bandage/cast placement, changing of the support 2-3 days later will allow adjustment once limb swelling is reduced. Similarly, early changes are recommended if one is concerned about skin viability, for example when wound closure was possible only under increased tension.

Young large or giant breed dogs with a big growth potential may be prone to bandage complications. These dogs can “outgrow” the bandage within a short period of time. In addition, these dogs are usually highly active. These factors may predispose them to development of complications. Bandage evaluations/changes every week should be considered in these patients.

In contrast, if external coaptation is used as the primary support method for a fracture repair, premature cast changes may lead to complications with fracture healing. Motion at the fracture site during cast changes can lead to loss of bone fragment reduction, it can devascularize bone fragments with subsequent delay of healing that may, in the worst case scenario, result in non-healing of a fracture. To find a compromise, bandage/cast changes in these cases may be performed carefully in a heavily sedated patient every 3-4 weeks.

Some prefer to evaluate the bandage/cast using obvious parameters such as foul odor, drainage, loosening, chafing, instability, or obsessive licking/chewing at the bandage/cast as indicators that a bandage change is necessary. At that time, however, serious skin damage has usually occurred and can be of concerning degree.

**Bandage complications** are common. Causes are usually negligence in application of or care for and protection of the bandage and ignorance of warning signs. Joint stiffness is frequently observed and occurs soon after joints are immobilized. Soft tissue contraction and fibrosis occurs during joint immobilization. The severity of stiffness is related to the time of coaptation and severity of injury. Physical rehabilitation and massage of the affected joints helps in most cases to reverse this problem. **Limb swelling** can be caused from a too tightly applied bandage. Venous and lymphatic congestion can, in the worst case scenario, lead to irreversible ischemia and necrosis of skin within 2-3 hours. Development of **pressure sores and skin ulcers** are frequently the result of inappropriate application of bandages/casts and ignorance of bony protuberances such as the epicondyles of the elbow, accessory carpal bone, malleoli of the tibia or the calcaneous. Appropriate bandage/cast confirmation and adjustment to prevent increased pressure at the predisposed sites is recommended to avoid these complications. **Loosening and slippage of bandage material**, associated with increased activity or accumulation of moisture in the bandage material can also lead to cutaneous erosions. In the worst case scenario, severe infection of skin or underlying tissues, necrotizing cellulites and fasciitis...
can progress to a degree that requires limb amputation. Aggressive early therapy is indicated to treat these problems. Frequent bandage changes and application of appropriate wound treatment are necessary. Occasionally, the application of an external fixator may be indicated. This allows open wound treatment while providing stability to the leg.

**Prevention of complications** can be achieved by adherence to basic bandaging principles, associated with proper bandage care, education of clients, and frequent bandage evaluations combined with meticulous bandage changes. The layering of bandage material should be evenly applied and tension applied uniformly. Bony protuberances should be protected. Exercise should be limited. Sedatives should be considered to decrease the level of activity in certain patients. Bandages have to be kept dry and clean and need to be changed on a regular basis, if they are soiled, wet, or if there are any concerns. Bandages should be changed early if applied to legs that are swollen at the time of first bandage application. Clients have to be educated and their predictable compliance has to be taken into consideration when recommendations are made for frequency of re-evaluations.

**Bandage removal** depends on the indication for the original application. When open wounds have developed a healthy granulation bed and epithelialize, it is frequently not necessary to leave the bandage on. The wound will heal over time. In these cases it is extremely important to ensure that no self-mutilation occurs. The E-collar must not be removed until wound healing is complete.

When a cast or splint is necessary to support a primary bone repair using internal fixation, removal of external coaptation can be performed 4-8 weeks after surgery. If radiographic bone healing is not adequate, additional coaptation may be required for another 4-6 weeks. This is occasionally necessary after pancarpal or pantarsal arthrodesis. In these cases, a stepwise decline of rigidity of external coaptation can be considered. A bi-valved cast can be reduced to a halve-valved cast that is left in place for 2-3 weeks. This can then be reduced to a modified Robert-Jones-Bandage, left in place for 2-3 weeks prior to complete removal of the entire bandage.

External coaptation used as sole repair for fractures in immature dogs, for example to treat greenstick fractures, can usually be removed after 3-6 weeks – depending on the age of the animal and severity of the fracture at the time of presentation. Radiographs have to be taken (without cast; animal sedated) to assess bone healing. If adequate healing is evident, re-application of the cast is not necessary. In these cases, however, stepwise decline of rigidity of external coaptation can be considered (see last paragraph).

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**Footnotes:**

a) **Telfa-Pad.** [www.kendallhq.com](http://www.kendallhq.com). Approx. $7/50 pads.

b) **Cast padding.** Medical Specialist Cast Padding. [www.bsnmedical.com](http://www.bsnmedical.com). Approx. $25.

c) **Roll gauze.** Johnson & Johnson Rolled Gauze Bandage. [www.jnj.com](http://www.jnj.com). Approx. $ 15./

d) **Vetrap.** 3M Health Care. Vetrap Bandaging Tape. [www.3m.com](http://www.3m.com). Approx. $1-2/roll.


f) **No Chew Vetrap.** PetFlex No Chew. [www.quickmedical.com](http://www.quickmedical.com). Approx. $20-60/5 rolls.

g) **Aluminum rods.** [www.onlinemetals.com](http://www.onlinemetals.com).
h) **Meta Mason Splints.** Extension splints. www.jorvet.com. $40-50 per set, dep. on size.
k) **Fiberglass cast.** 3M Immobilization. www.3m.com. Approx. $10/roll, dep. on size.
l) **M-Pact® American Orthopedic™ Cast Cutter.** www.alimed.com. Approx $1,400.
m) **Orthopedic Saw Kit.** www.jorvet.com. Approx. $750.
n) **Ioban.** 3M™ Ioban™ 2 Antimicrobial Drape. www.3m.com. Approx. $100/10 drapes.
o) **Cast protection bags.** www.cleanbreakprotector.com. Approx. $5-30, dep. on size.

**References/Suggested reading material**

