

SLU Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Surgical sutures

手術用縫合糸

The Basics and Introduction to advanced level
基礎・紹介から上級レベル

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 LinkedIn: <https://www.linkedin.com/in/odd-viking-hoglund-20734426/>
 Research Gate: https://www.researchgate.net/profile/Odd_Hoglund/contributions

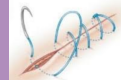
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Surgical sutures

手術用縫合糸

Terminology	用語
Suture materials and needles	縫合材料および針
Choice of sutures	縫合糸の選択

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There is no perfect suture...

完璧な縫合糸は存在しない

Use smallest size that can hold the tissue	組織を保持できる最小サイズを使用
Minimal friction and secure knots	最小限の摩擦と安定した結び目
Minimal tissue reaction	最小限の組織反応
Not beneficial for bacteria	細菌には有益ではない

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Choose your suture

縫合糸の選択

Which tissue are we suturing? どの組織が縫合するか？
 Time needed for tissue to heal? 組織の回復に必要な時間は？
 Need of resorbable suture, or suture that will be removed?
 再吸収可能な縫合糸、または縫合糸除去の必要性は？
 Consider other factors, wound tension, possible infection, risk of slow healing?
 傷の緊張、感染の可能性、治癒の遅さによるリスクといった他の要因を考慮。

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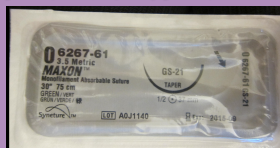
Sutures – terminology (I)

縫合糸 - 用語(1)

Biological material (catgut & silk), or Synthetic 生物学的材料(カッタット、シルク)、合成

Resorbable & non-resorbable material 吸収性・非吸収性材料

Monofilament & multifilament モノフィラメント・マルチフィラメント

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Sutures – terminology (II)

縫合糸 - 用語 (II)

サイズ: 4-0, 3-0, 2-0, 0, 1, 2 (小 - 大) Size: 4-0, 3-0, 2-0, 0, 1, 2 (smaller --- larger)

経時的な機械的性質(張力保持率) Mechanical properties over time (Tensile strength retention)

吸収時間 Resorption time

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VICRYL Plus バイクリル プラス
PDS Plus PDSプラス
VICRYL バイクリル
MONOCRYL モノクリル

Resorbable and non-resorbable 吸収性および非吸収性材料

Vicryl Monocryl Maxon PDS Catgut	Monosof/Ethilon Prolene Steel Silk
--	---

材料は劣化し、再吸収される
末期段階: 結合組織
The material degrades and is resorbed
End stage: connective tissue

恒久的な材料
Permanent material

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PDS Plus PDSプラス
VICRYL バイクリル
MONOCRYL モノクリル

効果的な組織サポート Effective tissue support 吸収可能な縫合糸 Resorbable sutures

元の強度の%対日数
例: 3週間でバイクリル40%
"時間経過に伴う力学特性"

% of original strength versus
number of days
Example: Vicryl 40% at 3 weeks
"Mechanical properties over time"

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PDS Plus PDSプラス
VICRYL バイクリル
MONOCRYL モノクリル

効果的な組織サポート Effective tissue support 吸収可能な縫合糸 Resorbable sutures

元の強さの20~25%保持...

20-25% of original strength remains after...

VICRYL* Rapide	1 week 1週間後
MONOCRYL* undyed/non-color	2 weeks 2週間後
MONOCRYL* violet	3 weeks 3週間後
VICRYL*	4 weeks 4週間後
PDS*	8 weeks 8週間後

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PDS Plus PDSプラス
VICRYL バイクリル
MONOCRYL モノクリル

吸収時間 Resorption time ...再吸収可能な縫合糸 ...of resorbable sutures

材料が組織から消失するのに必要な時間
「効果的な組織サポートのための時間」と同じことではない。
Time needed for material to disappear from tissue
Not the same thing as "Time for effective tissue support"

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VICRYL バイクリル
MONOCRYL モノクリル

Critical healing time – effective tissue support クリティカルヒーリングタイム - 効果的な組織サポート

Skin 肌	5-7 Dagar	5-7日
Mucus membrane 粘膜	5-7 Dagar	5-7日
Subcutaneous 皮下	7-14 Dagar	7-14日
Fascia 筋膜	14-28 Dagar	7-28日

縫合の選択

Rapide	Choice of suture	1 VECKA	1週間
MONOCRYL	Ofärgad 2 VECKOR	Färgad 3 VECKOR	2~3週間 染められていない
VICRYL		4 VECKOR	4週間
PDS			6-10週間

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Size of suture 縫合糸のサイズ

Metric	USP	Durchmesserspanne in mm
0.01	12-0	0.001-0.009
0.1	11-0	0.010-0.019
0.2	10-0	0.020-0.029
0.3	9-0	0.030-0.039
0.4	8-0	0.040-0.049
0.5	7-0	0.050-0.059
0.7	6-0	0.070-0.079
1	5-0	0.100-0.149
1.5	4-0	0.150-0.199
2	3-0	0.200-0.249
2.5	2-0	0.250-0.299
3	2-0	0.300-0.349
3.5	0	0.350-0.399
4	1	0.400-0.499
5	2	0.500-0.599
6	3	0.600-0.699
7	5	0.700-0.799
8	6	0.800-0.899
9	7	0.900-0.999

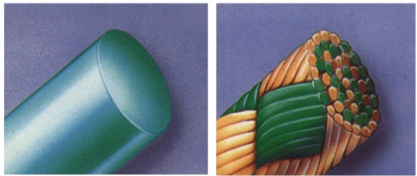
メトリック - USP - 直径(mm)
Metric - USP - diameter in mm

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Construction of suture 縫合の構築

Monofilament & multifilament モノフィラメント・マルチフィラメント
Mono: less traumatic, no space for bacteria, but less easy to tie
モノラル: 外傷が少なく細菌の混入スペースはないが、結びにくい



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Construction of suture 縫合の構築

マルチフィラメント: 結びやすいが、摩擦が大きく縫合糸中に細菌が混入する可能性がある
現在: 常にコーティングされ、外層による保護
Multifilament: easier to tie, but more friction and may be contaminated with bacteria inside suture
Today: always a coating, protection by outside layer



Unprecedented pliability and smooth passage through tissue.
The first and only suture to inhibit bacterial colonization of the suture.

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3.5 Metric MAXON Multifilament Absorbable Suture 30" 75 cm GREEN / VERT GRÜN VERDE

GS-21 TAPER 1/2 (37 mm) ADJ1140

Syneture

Needles and sutures 円の一部で表現された針 Needle described by part of circle

3/8 Circle 1/2 Circle 5/8 Circle

Compound Curve Straight Multicurve

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Needles and sutures Taper point needles

切断せずに組織を分離
フラットな構造 - 組織の浸透や分離が容易 (例: 腸)
Separates tissue without cutting
Taper point plus: flat structure – easier penetration and separation of tissues, for example intestines

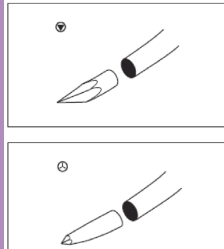


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Needles and sutures Taper cut

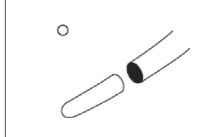
ニードルの先端で切断
良好な浸透力と少ない外傷
Cuts at tip of needle
Good penetration and less trauma
Examples: V-series and CC-series

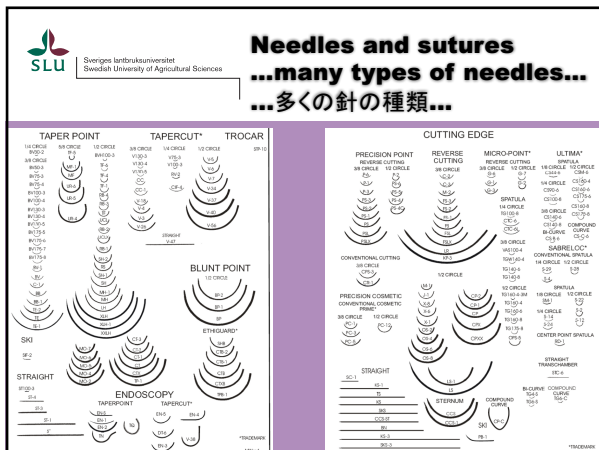


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Needles and sutures ...and more needles...

壊れやすい組織 - 脾臓、肝臓、腎臓
Fragile tissue – spleen, liver, kidney





Needles and sutures
角針 - 重要!
Cutting needles – important!

逆三角針
従来の切断
Reverse cutting
Conventional cutting

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Surgical sutures
手術用縫合糸
Introduction to advanced level
上級レベルの入門

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Infection and contamination
感染と汚染
インプラントがある場合、感染に必要な細菌はほとんどない
縫合糸 = "インプラント"
Where there is an implant, few bacteria are needed for infection
Suture = "implant"

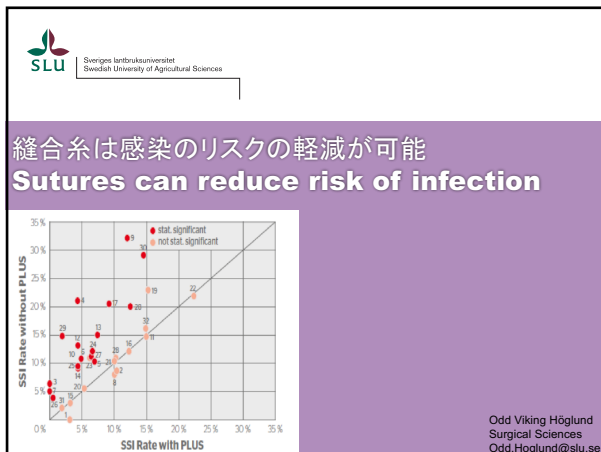
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Infection and contamination
感染と汚染
縫合糸の表面構造は、CDディスクのカバーに類似
150cm、1-0マルチフィラメント縫合糸の表面積 = 130cm² = 11.4x11.4cm
The surface of a suture is similar to cover of a CD disc
The surface area of a 150 cm, 1-0 multifilament suture = 130 cm² = 11,4 x 11,4 cm

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縫合糸は感染のリスクの軽減が可能
Sutures can reduce risk of infection
Antibacterial Plus Sutures

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モノフィラメント縫合糸 PDS PLUS®
プレイデ縫合糸 COATED VICRYL PLUS®
(PDS プラス) (VICRYL プラス)

(triclosan)

トリクロサンは、フェノール置換基を有するクロロ化ジフェニルエーテル
O,4'-トリクロロ-2'-ヒドロキシジフェニルエーテル。
分子量: 289.54 です。トリクロサンは、本項において
1972 年に医薬品として承認されています。

縫合糸は感染のリスクの軽減が可能 Sutures can reduce risk of infection

トリクロサン含浸縫合の使用は、小児における手術部位
感染の発生率を半減させた。
52 % reduction in the rate of SSI (surgical site infection) in pediatrics,
random controlled trial with >1500 patients
The use of triclosan-impregnated sutures reduced by half the incidence of
surgical site infections in children.
Renko, 2017, The Lancet
<http://www.sciencedirect.com/science/article/pii/S1473309916303735>

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縫合糸は感染リスクの軽減が可能 Sutures can reduce risk of infection

トリクロサン縫合はWHOによって推奨されている
獣医師の間での使用?
Triclosan-sutures are recommended by WHO
Use among veterinarians?

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Sutures at a molecular level 分子レベルでの縫合

VicrylとVicryl Rapidの違いとは?
時間の経過とともに吸収時間と力学的性質が異なる理由とは?
Why the difference between Vicryl and Vicryl Rapid?
Why are resorption time and mechanical properties over time
two different things?

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All synthetic resorbable implants (polymers) are based on 5 monomers

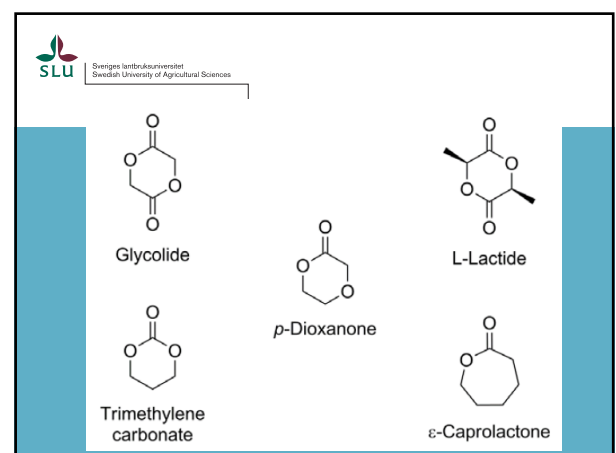
すべての再吸収可能なインプラント(ポリマー)
は、5つのモノマーからなる

<http://pub.epsilon.slu.se/3559/> P 16: Polymers in medicine

Epsilon Oppla arkiv

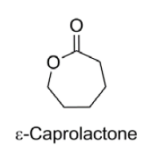
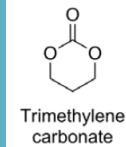
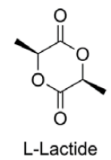
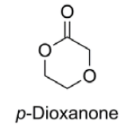
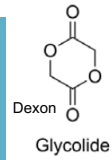
Item	On	Status	Sliding
A resorbable device for ligation of blood vessels			
development, assessment of surgical procedures and clinical evaluation			
Hoglund, Odd Viking (2012). A resorbable device for ligation of blood vessels. Thesis. (master's degree) Uppsala : Sveriges lantbruksuniversitet. Acta Universitatis Agriculturae Suecica. 1002-4880 : 20122 ISBN 978-91-8753680-9			
[PDF-filer]			
1128 7298			

GENERIC NAME	TRADE NAME
Chromic surgical gut (catgut)	—
Polyglactin 910	Vicryl and Vicryl Plus
Polyglycolic acid	Vicryl Rapide
Glycolide/lactide polymer	Dexon "2" (uncoated) Dexon II (coated)
Polydioxanone	PDS II
Polyglyconate	Maxon
Polyglactone 25	Monocryl
Glycomer 631	Biosyn
Polyglytone 6211	Caprosyn



最初の吸収性合成縫合糸
First resorbable synthetic suture

DEXON
GA



VICRYL

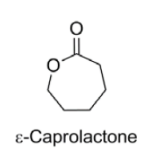
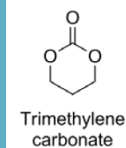
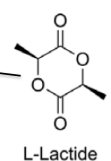
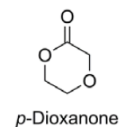
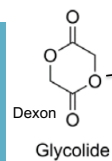
バイクリル

第2の再吸収性合成縫合糸
The second resorbable synthetic suture

VICRYL
GA+ Lactid

VICRYL

バイクリル



Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Polysorb®	PGA/PLLA	90/10	Lactomer

Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
PDS®	PDO		Polydioxanone



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Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Maxon®	PGA/TMC	67/33	Polyglyconate


Glycolide


L-Lactide


p-Dioxanone


ε-Caprolactone


Trimethylene carbonate

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Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Monocryl®	PGA/PCL	75/25	Poliglecaprone 25


Glycolide


L-Lactide


p-Dioxanone


ε-Caprolactone


Trimethylene carbonate

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Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Biosyn®	PGA/TMC/PDO	60/23/17	Glycomer 631


Glycolide


L-Lactide


p-Dioxanone


ε-Caprolactone


Trimethylene carbonate

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Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Caprosyn®	PGA/PCL/PLLA/TMC	68/17/7/7	Polyglytone 6211


Glycolide


L-Lactide


p-Dioxanone


ε-Caprolactone


Trimethylene carbonate

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Table 1. Multifilament and monofilament resorbable sutures, adapted from "Biomaterials Science, an introduction to materials in medicine" (Roby & Kennedy, 2004)

Trade name	Polymer(s)	Composition %	Generic name
Dexon®	PGA		Polyglycolide
Vicryl®	PGA/PLLA	90/10	Polyglactin 910
Polysorb®	PGA/PLLA	90/10	Lactomer
PDS®	PDO		Polydioxanone
Maxon®	PGA/TMC	67/33	Polyglyconate
Monocryl®	PGA/PCL	75/25	Poliglecaprone 25
Biosyn®	PGA/TMC/PDO	60/23/17	Glycomer 631
Caprosyn®	PGA/PCL/PLLA/TMC	68/17/7/7	Polyglytone 6211

A resorbable device for ligation of blood vessels
<http://pub.epsilon.slu.se/8589/>

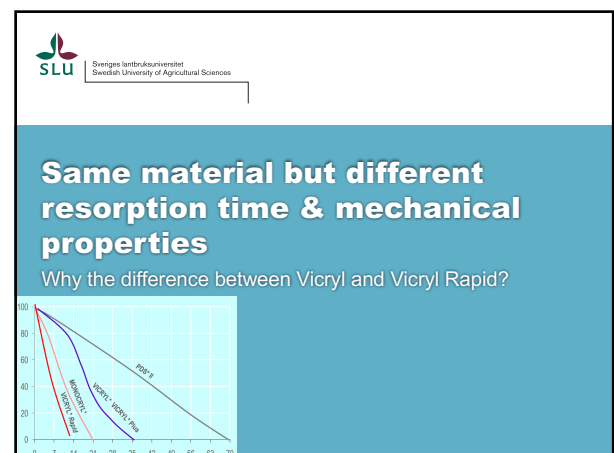

Glycolide


L-Lactide


p-Dioxanone


ε-Caprolactone


Trimethylene carbonate



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Polyglactin 910	Vicryl and Vicryl Plus	Ethicon	Absorbable Multifilament	25% at 14 days 50% at 21 days; 50% at 5 days 100% at 14 days	56-70
	Vicryl Rapide	Ethicon	Absorbable Multifilament		42

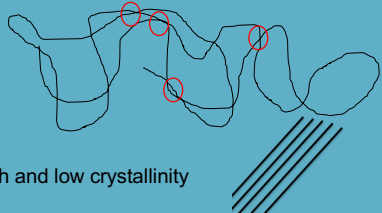
Radiation – shorter molecules

Vicryl Rapide has been radiated
Molecular chains are cleaved



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Length of molecule affects mechanical properties and also crystallinity



High and low crystallinity

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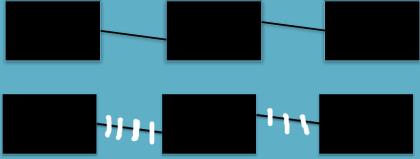
Polydioxanone	PDS II	Ethicon	Absorbable Monofilament	14% at 14 days 31% at 42 days	180
Polyglyconate	Maxon	Covidien	Absorbable Monofilament	30% at 14 days 45% at 21 days	180

Same resorption time but different mechanical properties over time

14日後の損失は14%および30%であるが、同じ再吸収時間である。なぜ？

Loss of 14 % and 30 % after 14 days – but same resorption time. Why?

SLU Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences



ブロック共重合体
Block-co-polymer

SLU Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

**質問はありますか？
Questions?
ありがとうございました！
Thank you!**



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