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Bioabsorbable Screws for Pelvic Osteotomies in Children

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i R-Aulan, Mölndals sjukhus, Göteborgsvägen 31, Mölndal, den 4 februari 2022, klockan 09:00 av

Henrik Hedelin, legitimerad läkare

Fakultetsopponent:
Professor Carl Johan Tiderius
Lunds universitet, Sverige

Avhandlingen baseras på följande delarbeten

I. Hedelin H, Larnert P, Hebelka H, Brisby H, Lagerstrand K, Laine T
Innominate Salter osteotomy using resorbable screws: a retrospective case series and presentation of a new concept for fixation. J Child Orthop. 2019 Jun 1;13(3):310-317

II. Hedelin H, Hebelka H, Brisby H, Laine T
MRI evaluation of resorbable poly lactic-co-glycolic acid (PLGA) screws used in pelvic osteotomies in children-a retrospective case series. J Orthop Surg Res. 2020 Aug 14;15(1):329

III. Hedelin H, Larnert P, Antonsson P, Lagerstrand K, Brisby H, Hebelka H, Laine T
Stability in Pelvic Triple Osteotomies in Children Using Resorbable PLGA Screws for Fixation. J Pediatr Orthop. 2021 Aug 191;41(9):e787-e792

IV. Hedelin H, Bryneskog E, Larnert P, Iraeus J, Laine T, Lagerstrand K
Post-operative stability following a triple pelvic osteotomy is affected by implant placement- a finite element analysis.
(In manuscript)

SAHLGRENSKA AKADEMIN
INSTITUTIONEN FÖR KLINISKA VETENSKAPER

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Bioabsorbable Screws for Pelvic Osteotomies in Children

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Abstract

Multiple conditions, with developmental dysplasia of the hip being a prime example, affect the congruity of the pediatric hip joint. A Salter osteotomy (SO) or a triple pelvic osteotomy (TPO) can be used to address suboptimal biomechanical conditions in the hip joint by improving containment and load distribution. Traditionally these osteotomies use metal implants to stabilize the osteotomy of the ilium, necessitating a second surgery for implant removal. If Kirschner-wires are used there are also risks related to wire migration and lack of stability. The general aim of this thesis was to explore the novel use of poly lactic-co-glycolic acid (PLGA) screws for osteotomy fixation in SO and TPO. The feasibility of this concept was examined regarding the stability of fixation as well as the biocompatibility of the implants. Bioabsorbable screws negate the need for implant removal which would be a major benefit for children.

Study I reported on a novel surgical method for SO using PLGA screws instead of metal implants. A case series of 21 patients was reported on and the stability of the osteotomy fixation was evaluated using the post-operative radiographs. Migration percentage, acetabular index and center-edge angle were used to decide if an osteotomy collapsed or remained stable. In all patients but one the osteotomy remained stable and healed with maintained perioperative correction. There were no local reactions to the bioabsorption of the screws.

Study II presented a retrospective analysis of the bioabsorption of 4.5mm PLGA screws as interpreted on Magnetic Resonance Imaging (MRI). Twelve patients who had undergone a SO or TPO with PLGA screws as the method of fixation were included. Eighteen MRIs were performed 0.5-4.5 years postoperatively and were analyzed according to eight parameters. After 2-4.5 years all screw canals were replaced with >90% bone with one exception where most, but not 90%, was replaced with bone. The local reactions seen during the bioabsorption were minor.

Study III described a modified surgical method for TPO utilizing PLGA screws for the ilium osteotomy. A case series of 11 patients was reported on and the postoperative stability of the osteotomy was evaluated using migration percentage, acetabular index, center-edge angle as well as Sharp's angle. The osteotomy angle (OA) was, as an addendum, suggested as a parameter to evaluate the integrity of an osteotomy. All patients maintained the initial correction and there were no signs of implant failure nor any local reactions to the implants.

In ***Study IV*** the finite element method was used to analyze how different screw configurations affect stability in a TPO. Relative flexibility for loads in all translational degrees of freedom was calculated for five different screw configurations in a standardized hemi-pelvis. In two of these configurations the entry points used are only viable options if bioabsorbable implants are used. The screw configurations with a more perpendicular angle to the osteotomy and with a greater spread in the osteotomy plane between the screws resulted in increased stability. The use of bioabsorbable implants enables entry points that can provide improved biomechanical stability in a TPO.

In summary, the presented studies support that 4.5 mm PLGA screws provide sufficient stability in SO and TPO in children with no major local reactions to the implants. After bioabsorption the screw canals were mostly replaced by bone and the use of bioabsorbable implants enables fixation configurations that seems to improve stability of the osteotomy. The use of bioabsorbable screws for pelvic osteotomies can eliminate suffering associated with a second surgery and save resources.

Keywords: pelvic, osteotomy, triple, salter, DDH, Perthe's, PLGA, bioabsorbable

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